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A MENACE TO ELECTRIC LIGHTING.

THE dog which dropped the real bone into the water in its endeavour to secure the imaginary one did not achieve fame by reason of its wisdom. Nor will the Edison and Swan Electric Lighting Company be voted wise by people of common sense if it persists in the attempt it appears to be making to break up existing installations of the electric light where rival lamps to its own are in use. This company, as our readers are well aware, had the good fortune to be on the winning side in a recent law suit which it brought against Messrs. Woodhouse and Rawson for infringement. Not content with the success thus gained, and the benefits in the shape of damages or royalty which it may derive from the offending manufacturers, the Edison Company has now, according to information supplied to us, notified the purchasers of lamps from other makers that they are to discontinue the use of those lamps.

We perceive in this ill-advised course of action a distinct danger to the advancement, and even to the continuance of electric lighting. We are told that the company is acting perfectly within its legal rights in this matter. That may be; but is it not possible to go too far in pursuance of legal rights for one's own advantage? We imagine so, and that, it appears to us, is just what the Edison Company is doing. Have the directors considered thoroughly what is likely to follow their present selfish policy? Has it occurred to them that they may possibly harm the interests of their own company whilst seeking to advance them by such high-handed means? Can they not see that the natural result will be that consumers, and would-be consumers, will become disgusted with the state of things obtaining, and will discard or refuse to have anything to do with the electric light whilst they are liable to be inveigled into litigation? In an instance which has come under our own observation a large installation has been put up in a private residence at considerable expense. Four hundred incandescent lamps are in use, and the installation has been running for close upon two years. It was with some amazement that the owner of this installation a few days ago received a demand from the Edison Company for the surrender of the lamps which he bought nearly two years ago, an action for damages being suggested as the result of non-compliance. It will indeed be strange if this consumer feels so pleased with the notification that he is "an infringer" and must cease to be so, that he will surrender the lamps he now possesses and immediately purchase a fresh set from the very people who are disturbing him. Yet this, as far as we can see, is the only way in which the Edison Company can expect to derive any permanent benefit from its proceeding. There are many other similar installations throughout the country, and it will be nothing short of a calamity if they are to be interfered with in this ruthless manner. Lamps which have been in use for two or more years were certainly bought without an idea of infringement, and it is only calculated to bring discredit upon the industry to sue the purchasers for damages; if infringement is clearly proven, the most reasonable plan, to our way of thinking, is to recover from the manufacturers, who make and sell with a full knowledge of the responsibility they incur, and the risk they run. They do not usually communicate to their customers the fact that there is danger of their being proceeded against for using the lamps supplied, and the latter, if they can be said to err at all, usually do so in ignorance. It seems to us only right that a tacit guarantee of indemnification from all evil consequences should be held to accompany every sale under such circumstances. Possibly the demand for the possession of the lamps is little more than a figure of speech, the real desire being to enter into an arrangement for the payment of royalties. Demands of this kind upon the pockets of innocent persons might be profitable for a time, but the policy is questionable if its eventual effect is to restrict the progress of electric lighting. For if the Edison Company is moderately successful in this direction, there is a possibility that another well-known corporation might follow suit, and try in earnest to create a "corner" in compound-wound dynamos; then a third electrical company might pursue similar tactics with regard to secondary batteries; and some other firm might have sufficient boldness to lay claim —and there would be a fair prospect of success—to the use of copper conductors covered with insulating material for electric lighting purposes.

We think the Edison Company would act much more sensibly if it allowed installations actually in operation previous to the recent legal suit to remain *in statu quo*, enforcing its rights against infringing manufacturers and all future users of infringing articles as fully as it thinks fit. Now is the time when the company has it in its power either to make friends or enemies. Which will be the better course for themselves we leave to the directors to decide; but we have a strong conviction that the plan apparently adopted will, if carried out, exercise a much more baneful interest upon the electric lighting industry than Electric Lighting Acts and the competition of gas companies combined.

We feel that this is a serious matter. In the present state of affairs what consulting engineer would have the temerity to advise his clients to adopt electric lighting? None, we imagine, but one who had a strong *penchant* for the Edison-Swan system. We ourselves are occasionally appealed to as persons who should know a little respecting the advantages and otherwise of electric lighting. Could we, under present circumstances, advise a friend that he would do well to install the electric light? Certainly not.

Did we so advise him, we should expect to lose both our friend and our reputation for candour. Electric lighting is an undertaking to be by no means lightly entered upon under the best conditions, for the difficulties in the way of proper working are many and great. More care and watchfulness than most householders would desire to exercise are absolutely necessary to ensure a full measure of success. If in addition to the natural anxieties attendant upon such circumstances owners of private installations are to have hanging over them the perpetual fear of an injunction or an action for damages, their lot will indeed be not a happy one; those who are not owners will, it is needless to say, take warning, and carefully abstain from placing themselves in so unenviable a position.

It has been suggested to us that one result of this action of the Edison Company will be to stimulate invention in other directions. It will be a bold man who will venture to predict that any incandescent lamp which may be constructed will escape unharmed from the clutches of the Edison Company if the latter resolves to "go" for it. Doubtless men will work in the mere hope of producing something novel, and their success, if it comes, will be welcome; but it is scarcely probable that it will be sufficiently valuable to atone for the arrest of the development of electric lighting which we are likely to witness if present appearances continue. Small arc lamps may possibly come much more largely into use. They may with advantage be employed in many instances; but they can never be efficient substitutes under all conditions for incandescent lamps.

We trust, however, that our fears are capable of dissipation, and that the directors of the Edison Company will recognise that it will be wiser not to administer this threatened blow to electric lighting.

ELECTRO-MOTORS.

REGARDING the theory of electro-motors, much misunderstanding still prevails amongst many of those who consider they have a fair claim to the title of electrical engineer. A dynamo machine working as a generator they think they understand, but come to deal with motors hopeless mystification ensues, and in their minds counter E.M.F. torque and static effort are mixed up in one unintelligible tangle. This is not to be wondered at, for the strangest notions have been promulgated from time to time regarding this class of apparatus. We have been told that generators and motors must be constructed on different lines, and that the conditions which are requisite in the former for efficient working are to be reprobated in the latter. It has been stated that whereas in a dynamo we work by repulsion, in a motor we work by attraction. In a standard work we farther learn that the armature current in a generator reacts to weaken the field while in a motor it reacts to strengthen the field, and we have in the same work a motor illustrated in which the brushes are displaced *backwards*. We are informed that a motor with a backward displacement to the brushes must be uneconomical, and, lastly, an experimenter has discovered that a motor must be less efficient than a generator because the eddy currents in the armature core are strengthened by the inductive action of the current round the core. All these fallacies must be rooted up. With so many different opinions, is it any wonder that the student, bewildered, begins to think the theory of motors but a crude one?

In the past, generally motors have been much less efficient than generators, but side by side with this fact let it be remembered that they have been made much smaller, and the reason of their low efficiency is apparent. We know of no theoretical reason for a motor being less efficient than a generator, and were the demand for motors considerable, we are sure that they could be made as efficient. As a matter of fact, a dynamo run as a motor has always a higher electrical efficiency than when running as a generator at the same speed and current, and if the conversion efficiency is the same as in a generator, and there is no reason to believe it is not, then it is demonstrable that the motor is the more efficient machine. If we call the current, C, the resistance of the motor, R, and the electromotive force generated by the machine either as a generator or motor, E, then the electrical efficiency of the generator is $\frac{E - C R}{E}$, the electrical efficiency of the motor being $\frac{E}{E + C R}$, which is higher. In the latter case a greater amount of work is being done than in the former case, but if the work done externally is the same in the generator as in the motor, then in the latter it is obtained with the same efficiency at a slower speed. It is perfectly immaterial, so far as the E.M.F. generated by the armature is concerned, whether the machine is driven by a belt or by a current sent through its own coils; in either case it depends on the strength of the field and on the speed of rotation, and provided there is no disturbing action due to the rotation of the armature, the value of the E.M.F. produced will be in each case similar. Though the latter point has been a great stumbling block to the student, everything becomes easy when we treat the dynamo as a reversible machine. Let us trace one or two of the relations in motor and generator.

If we take a series dynamo and send through it different currents preventing the armature from revolving by opposing its turning moment with weights placed in a scale pan at some distance from the axis, we can trace out a curve in which is shown for each particular current the relation between it and the turning moment. If we are to work under the proper conditions for the motor, the brushes in the latter ought to have the same backward displacement, as in the generator they have a forward displacement, and if this is done it is perfectly clear, assuming, for the moment, no friction, that the machine is reversible, it making no difference whether the current turns it as a motor lifting a weight, or a force applied to a pulley turns it as a generator producing the current. The torque, or turning moment in a generator, is proportional to the product of the current flowing in the armature and the strength of the field, and in a motor the same relation holds good. It is not denied that a stronger resultant field may be produced by giving the brushes in a motor a forward lead, but it is refuted that a motor with a backward displacement is less efficient than a generator with a forward displacement, for, indeed, the resultant fields are similar in motor and generator, and we argue, therefore, that if it is right for the latter to have a forward lead, in the former the brushes ought to be set backwards.

If we wish to make a generator do the same work at a higher speed this means that while the number of revolutions of the machine is increased the torque must be reduced in the same proportion, or, in other words, the machine to produce the same E.M.F. must run faster, the current remaining as before. We can effect this alteration either by reducing the strength of the field, or by reducing the number of convolutions on the armature, and we do precisely the same thing in the case of a motor. If the motor is to run faster it means that a higher speed must be attained by the armature before the counter E.M.F. attains its former value, and, keeping the strength of field as before, the

turns on the armature must be reduced accordingly; or if it is desired to take full advantage of the higher speed and do more work, the volume of wire on the armature must remain unaltered, its area being inversely as the convolutions, the current flowing being directly as the area, the torque being therefore equal to what it was at first, and the increased work being proportional to the increased speed.

Motors have been designed on different lines from generators in order to fulfil different conditions; otherwise there is no reason to depart from the lines now well recognised on which the latter are built. In a generator weight is frequently a secondary consideration and high efficiency a desideratum; in motors, on the contrary, high efficiency has not been considered essential, while light weight has been considered as of the greatest importance. Whether driven as a generator or motor, if a machine is to be efficient, it must necessarily be heavy as compared with one in which, for a given total weight, maximum output is obtained. There is no distinction here between motors and generators; the heaviest dynamo, which is most efficient when worked as a generator, would doubtless prove most efficient when worked as a motor, and the lightest machine would probably prove least efficient in both instances. That the reversibility of the dynamo will be more completely recognised ere long I feel certain, meanwhile if I have in any degree helped your readers to this recognition I shall not have written in vain. AN ENGINEER.

SOME ADDITIONAL FACTS CONCERNING THE REIS ARTICULATING TELEPHONE.

By PROF. EDWIN J. HOUSTON.

WHATEVER the decisions of the United States Circuit Courts have been in the past, or whatever they may be in the future, there can be no reasonable doubt, that in the opinion of the general scientific world, to Reis and not Bell will be accorded the credit of having made the great discovery of the methods and apparatus for the electrical transmission of articulate speech.

We have elsewhere maintained the following propositions, viz.:

1. Reis invented an instrument which he called a telephone, and which he said would transmit speech.

2. That this telephone operated by means of electricity, and consisted of transmitting and receiving apparatus.

3. That in the hands of Reis it did transmit intelligible articulate speech; and that credible witnesses are still alive who heard it so transmit speech.

4. That exact reproductions of the Reis apparatus, operated in accordance with his directions, will transmit speech now.

To the above it is answered, despite the published statements of Reis to the contrary,

1. That Reis devised his apparatus to transmit muiscal tones and not to transmit articulate speech.

2. That there is but one method by which articulate speech can be transmitted electrically, viz., by an undulatory current, and therefore Reis never could have transmitted articulate speech telephonically, since, it is alleged, he did not use the undulatory current. Any, consequently, who imagined that they heard articulate speech through the Reis apparatus must have been deceived.

3. That if reproductions of the original Reis apparatus have been made to transmit articulate speech, however exact they may appear, they must have been varied in some important (although inappreciable) respect.

The transparent sophistries of the above answers are, in our judgment completely swept away by the experiments of Mr. John R. Paddock, of the Stevens Institute of Technology, which although of an early date we have but recently received and had permission to publish. These instruments have been introduced into the Overland Telephone Cases, on appeal to the Supreme Court.

Mr. Paddock's experiments appear to clearly establish what at the outset should have been apparent to any fair enquirer; viz., that *the orginal Reis apparatus, without any change whatever, will transmit intelligible articulate speech.*

The apparatus used by Mr. Paddock, were the identical apparatus employed by Reis in his lecture before the Physical Society at Frankfort-a-M., in 1861–2. They were obtained by Hon. A. J. Keasbey, from Prof. S. P. Thompson, of Bristol, England, who got them from Dr. Theodore Stein, of Frankfort, Germany. Dr. Stein got them from Prof. Dr. Böttger, President of the Physical Society of Frankfort, who received them direct from Reis, after the above-mentioned lecture. The story as told above is fully substantiated by testimony taken at Frankfort-a-M.

The following letter from Mr. Paddock will, however, give the particulars at length.

Stevens Institute of Technology,
Hoboken, N.J., *February 12th*, 1886.

Prof. E. J. Houston, Franklin Institute, Phila.

I have read with much interest your articles in the London ELECTRICAL REVIEW relating to the telephone and the invention of Philip Reis.

Having facts concerning the same which have not yet been made public and which are of especial interest at this time I take the liberty of placing them at your disposal. In the summer of 1885 I came into the possession of the *Original Bored Block Transmitter* and *Knitting Needle Receiver*, exhibited by *Philip Reis* before the Physical Society, at Frankfort-a-M. in 1861–2. These instruments were obtained by Hon. A. Q. Keasbey, Counsel for the Overland Telephone Companies, from Prof. Thompson, of Bristol, England, who received them from Dr. Theodore Stein, of Frankfort, Germany, and he in turn from Prof. Dr. Böttger, President of the Physical Society of Frankfort, to whom *Reis himself* gave these instruments after the lecture above referred to. Their history is thus fully proved, and their identity has been further established by testimony taken at Frankfort-a-M.

The instruments were in a good state of preservation when received by me, and required no alterations or additions whatever with the exception of a wooden support for the needle of the receiver, which was wanting, and a slight mending of the wooden case which had become broken, evidently during transportation.

With these instruments I soon succeeded in transmitting and receiving good articulate speech. Musical sounds and songs were easily reproduced, and it is important to remark that when the transmitter was so operating as to transmit musical sounds *best* it was also so operating as to transmit articulate speech *best*, which, in view of the oft-repeated statement that the Reis instruments are capable of transmitting *the one*, but incapable of transmitting *the other*, is of especial value as showing that the same condition of the transmitter is required for both. The *pitch* of a musical sound was *not* the only result achieved by Philip Reis with his instruments, but also *amplitude* and to a good degree *quality* also, as is proved by the publications of his day (see "Annual Report of the Physical Society of Frankfort-a-M., 1861–2." Also "The Deutsche Industrie-Zeitung for 1863").

Mr. E. W. Smith, a practical telephone operator, assisted me in this work, and together we were able to transmit and receive many words and sentences in as *clear* and *distinct* a manner as in any *modern telephone*, and this notwithstanding that the instruments we were using were now nearly 24 years old, and that the diaphragm of the transmitter was made of a thin animal membrane which soon absorbs the moisture of the breath, and then of course loses its tension and fails to respond to the vibrations of the voice.

In describing the operation of this very instrument, Philip Reis, in his lecture before the Physical Society at Frankfort, makes the following statement:—

"If, now, sounds or sound combinations are produced in the neighbourhood of the block, so that sufficiently powerful waves reach the opening, *a*, then these sounds cause the membrane, *b*, to vibrate. At the *first condensation* the *hammer-like wire*, *d*, *is pushed back*, at the *rarefaction* it *cannot follow the retreating membrane, and the current* traversing the strip *is broken*, until the membrane forced by a new condensation again presses the strip (proceeding from *p*) against *d*. In this way *each sound wave causes a breaking and closing of the circuit.*" (The italics are Mr. Paddock's.)

This is the description chiefly relied upon to prove that the Reis instrument operates by means of a *broken current*, and hence is incapable of transmitting speech, for it is maintained a current *broken* at each vibration *cannot* transmit speech, and Reis distinctly says himself that the current *is* thus broken, therefore, &c.

We have endeavoured experimentally to test this most *vital point* so far as regards Reis and his instrument. Whether there are minute breaks in the current during the ordinary use of a

microphone transmitter is a matter still in doubt, and one which only indirectly bears upon this question.

The real question is—Did Philip Reis so operate his telephone as to break the current (as he supposed he did) and if so did he obtain speech in that way—(as he says he did).

We have operated the Reis instruments in *exact conformity* to his description and to *this* very paragraph of that description. When thus operated "the hammer-like wire *is* pushed back but *cannot* follow the retreating membrane and parts from it." A continual humming is kept up as the two platinum contacts strike one another, and a succession of sparks indicate the parting of the electric current at each vibration.

While *so* operating in exact accordance with the description of Reis himself, the following sentence has been distinctly transmitted and received:—

"*William H. Vanderbilt died suddenly at his house on Fifth Avenue, yesterday. He is said to have been worth two hundred million of dollars,*" a sentence of 23 words which of itself is clear proof that articulate speech can be transmitted in the Reis instrument when used with the *so-called broken current*. We are at present engaged in ascertaining the extent to which this old instrument will transmit speech under these conditions, and the work thus far done points to the conclusion that it is far greater than has hitherto been supposed. Photographic records will also be obtained of the vibrations produced under these circumstances which will form an interesting subject for study, and lead to more positive conclusions.

With reproduced forms of a later Reis instrument, viz., the cubical box form, we have transmitted speech at greater length—one sentence consisting of fifty-six consecutive words. A full statement of these experiments appears in the record of The Overland Telephone Cases, now on appeal to the Supreme Court.

With esteem and regards, Very truly yours,

JOHN R. PADDOCK,
Instructor in Physics and Chemistry.

The importance of the above statements, substantiated as we do not doubt they will be, can hardly be overestimated. If established, they sweep away completely the broad claims that the Bell Telephone Company have been so pertinaciously endeavouring to establish for Bell. They completely dispel the legal mists that have so skilfully been maintained around the early labours of Philip Reis, and hasten the time when the general public will be ready to do what the general scientific public, the world over, has already done, viz., accord to Philip Reis the credit due to his wonderful discovery.

The importance of Mr. Paddock's experiments will, perhaps, be the better understood by examining some of the recent decisions in the Circuit Courts on the legal value of the Reis apparatus as anticipations of the articulating telephone of Bell.

In the recent New Orleans Telephone decision in the case of the American Bell Telephone Company, *et al*, *v.* the National Improved Telephone Company, *et al*, Judges Pardee and Billings in their decision, spoke as follows:

"From the evidence submitted in the case it seems clear that now, in the present state of the art, neither that Reis's instruments nor any reproduction of them can be made to transmit articulate speech except by changes of some form in the instruments or by the employment of Bell's method."

"We therefore conclude that neither Reis nor his successors anticipated the invention of Bell as set forth in the fifth claim of his application and patent, and as illustrated by fig. 7, described in his accompanying specification."

But if the original apparatus, without any change will speak, what then?

In the American Bell Telephone Company *v.* Amos E. Dolbear, *et al*, Judge Lowell on August 25th, 1883, in giving the opinion of the Court in this case said: "The defendant now testifies that the Reis instrument can be made to transmit speech, under some circumstances, if operated in the way which Bell has shown to be necessary." . . . . . "The experiment made in the presence of counsel, which was intended to prove the correctness of the defendant's present opinion, was an utter failure. But if it be admitted that the Reis instrument is capable of such use, to a very limited extent, and after a change in its proportions, and when used in a way which the inventor did not intend, still, I am of opinion that it was not an anticipation of Bell."

But if the original apparatus without a change in its proportions, and when used in a way which the inventor intended will transmit speech, what then?

Alluding to the success in making the apparatus described in fig. 7 of Bell's original specification talk, Judge Lowell says:

"This great result has been reached by Mr. Bell entirely through the improvements described in his second patent (1877 patent) such as the substitution of a metal plate for a stretched membrane, and some others" and these early unsuccessful efforts he says are "now immaterial, for it is proved that the instrument will do the work, whether the inventor knew it or not, and in the mode pointed out."

But if it be now proved that the original apparatus will do the work, which its inventor claimed it would do (not which he hoped it would do, or was ignorant it would do), what then?

In a case that has been so full of surprises as the telephone litigations, we must confess to considerable curiosity as to what the courts and the legal advocates of Bell will do with the above evidence.

The author has not personally tried the experiments referred to, but hopes to do so on the first opportunity. Mr. Paddock promises to give him additional information at an early day.

Central High School, Philadelphia,
June 16th, 1886.

REMARKS ON THE SECOND PAPER OF MR. HUGHES REGARDING SELF-INDUCTION.

By Professor H. F. WEBER, in Zürich.

IN his first paper upon self-induction Mr. Hughes believed he had given the proof that:—Firstly, the coefficient of self-induction of non-magnetic straight wires depended extremely upon their physical nature; for he found, as relative values of the coefficients of self-induction of wires having the same dimensions, for

Copper	20	German silver ...	7
Brass	13	Mercury	2
Zinc	12	Carbon	1
Lead...	10		

And that, secondly, the coefficient of self-induction of a non-magnetic straight wire depended in a somewhat complicated manner upon the wire thickness, being for very thin and very thick wires much smaller than for those of mean diameters:—

Thickness =	0·1 mm.	0·25 mm.	0·50 mm.	1 mm.	2 mm.	3 mm.	4 mm.	5 mm.	6 mm.	7 mm.	8 mm.	9 mm.	10 mm.
Copper ...	13	14	16	20	24	26	28	23	22	20	17	15	12
Brass ...	7	8	9	13	20	23	25	26	26	24	22	20	15

In my paper, "Critical Remarks on the Newest Discoveries of Mr. Hughes Regarding Self-Induction in Metallic Conductors," (ELECTRICAL REVIEW, April 9th, 1886, pp. 321—323) I showed that Mr. Hughes had derived these results from his measurements in an incorrect manner, and I explained by developing the mathematical treatment for these measurements that Mr. Hughes's discoveries were purely the consequences of this incorrect interpretation given by him to his experimental results. The correctness of my deductions I further proved by the results of three series of measurements which I made to determine the coefficients of self-induction of wires of equal length and thickness, consisting of copper, German silver, and mercury. Employing the method of Mr. Hughes, and calculating the coefficient of self-induction in the right manner, I found no trace of influence of the nature of a non-magnetic metal on its coefficient of self-induction.*

* Mr. A. E. Conti's objection in the ELECTRICAL REVIEW, 30th April, 1886, p. 409, shows but a small insight into the contents of my paper. For he writes: "When laws of nature are in question it is rash and futile to attempt to confute the results of a series of experiments by the simple substitution of a few mathematical expressions, such as has been done by Professor Weber, of Zürich, in *La Lumière Electrique* and the ELECTRICAL REVIEW."

My theoretical objections to Mr. Hughes's manner of interpretation are all based upon clearly defined and well-known laws of nature.

By further rendering the experimental proof that the correct interpretation of the measurements obtained by Mr. Hughes's method gives as a fact that no influence is exerted by the nature of the non-magnetic metallic conductors on their coefficients of self-induction, I have done all that possibly could be done to firmly establish the correctness of my objections to the mode of interpretation employed by Mr. Hughes.

My critical remarks did not find the approval of Mr. Hughes; for he said in a short note in the ELECTRICAL REVIEW, 30th April, 1886, p. 407:—"Prof. Weber shows that the method which I employed admits of numerous errors, and, consequently, that the results which I have announced are due to an 'incorrect interpretation.' I must say that I am unable to agree with those opposing views . . . The only question which I consider important is, are the effects which I announced true physical effects due to the nature of the conductor, or are they simply due to some peculiarity of the method which I employed? To answer this I have constructed a new instrument based upon an entirely different method, one of extreme simplicity, one which does not allow of any possible error. I propose to publish a description of this instrument (together with the results obtained) during the coming month, when I hope that these demonstrations will prove clearly all that I have said as to the influence of the form as well as the nature of the conductor upon its self-induction."

The results of these new measurements, which should contradict my objections and affirm the discoveries published in the first paper, were communicated by Mr. Hughes to the Royal Society on the 29th May. (ELECTRICAL REVIEW, June 4th, pp. 525—530, and June 11th, pp. 558—560.)

A view of the contents of this new paper shows that Mr. Hughes has not done what he promised to do; at no point in the new paper has he even made an attempt to contradict my well-grounded objections; neither has he given experimental proof of the accuracy of the discoveries he described in his first paper. Without the least foundation Mr. Hughes continues to believe his ideas concerning the interpretation of the results of his first method to be correct. He does not directly combat my objections as being inaccurate, but the manner in which he speaks in the new paper of his former results shows that he in no way acknowledges the objections made by me to his mode of interpreting his measurements. He persists in regarding the angle read on the induction-balance to be a true relative measure for the coefficient of self-induction.

All I can do in answer to this behaviour is again to state that this opinion is an erroneous one, and that no interpretation differing from mine can be given to Mr. Hughes's experiments without violating natural laws which have hitherto been always found to be correct.

By a repetition of his first experiments Mr. Hughes would have been able to convince himself of the perfect accuracy of my views. This, however, Mr. Hughes did not even try to do, turning instead to a second method which appears to him to be very simple. He then investigated whether this simpler method gave him the same results which he derived from the first method or differing results.

This new method is based upon the principle that a variable current in the bridge of the Wheatstone quadrangle can only be constantly annulled, when the following two equations between the resistances, w_1, w_2, w_3, w_4, and the coefficients of self-induction, Q_1, Q_2, Q_3, Q_4, of the four sides:

$$w_1 w_4 - w_2 w_3 = 0,$$

$$\frac{Q_1}{w_1} + \frac{Q_4}{w_4} - \frac{Q_2}{w_2} - \frac{Q_3}{w_3} = 0$$

are satisfied.

The sides (3) and (4) of the quadrangle consist of two German silver wires perfectly alike; thus we have $w_3 = w_4$ and $Q_3 = Q_4$. By means of the variable length of a thin German silver wire, C_1, in the side (1) w_1 may be made equal to w_2. It remains, when this has been done, to make $Q_1 = Q_2$ for complete annulment of the current in the bridge. This is attained by means of a spiral of copper wire, A_1, introduced into the side (1), together with the wire, B_1, of which the coefficient of self-induction is to be measured, and by means of a second copper wire spiral, A_2, of the same sort combined with a German silver wire, B_2; this system of the wire A_2, and the wire B_2, forms the side (2) of the quadrangle. When the resistances, w_1 and w_2, have been made equal, then, by means of a collar, the one spiral is compressed, the other at the same time dilated until there is silence in the telephone. Then we have the coefficient of self-induction of the system of the copper wire spiral, A_1, the wire, B_1, and the German silver wire, C_1, is equal to the coefficient of the system of the copper wire spiral, A_2, and the German silver wire, B_2. From this equality must be derived the value of the coefficient of self-induction of the wire, B_1.

Mr. Hughes contented himself with a *relative* value for this coefficient, which he gained by calibrating his copper wire spirals as described in his paper.

The values given by this method can make no pretention to being exact, as their derivation is based upon the two suppositions that the coefficient of self-induction of a system of two wires is equal to the sum of the coefficients of self-induction of each wire taken singly and that the coefficient of self-induction of a straight wire is proportional to the length of the same.

This necessitates that the new results obtained by Mr. Hughes can only be approximately correct.

The principle of this method has already been employed several years ago by Mr. Lorenz, in Copenhagen, to determine the coefficient of self-induction; his way of working was, however, different, as he silenced the telephone by adjustment of the resistances, w_1, w_2, w_3, and w_4.

In reality both methods, the first and second, give the very same results, if properly interpreted. But for everyone who believes, with Mr. Hughes, the angle read on the induction balance to be a true measure for the coefficient of self-induction, this second method certainly gives results differing entirely from those obtained by the first method.

It would, therefore, have been very necessary for Mr. Hughes to have undertaken and treated of a fundamental examination into the nature and capacity of his two methods.

We, however, do not find any trace of this most desirable critique in the new paper; the differing results obtained by the two ways of measurement are simply stated, and it is left to the reader to accept either the results of the earlier method or the perfectly different results of the second.

In his first researches on self-induction Mr. Hughes believed that he had given the proof that the coefficients of self-induction of straight wires of the same length and thickness consisting of different non-magnetic metals have very different values:—

Copper	20	German silver ...	7
Brass...	13	Mercury	2
Zinc	12	Carbon	1
Lead	10		

As I maintained that this discovery was the result of a faulty interpretation of his measurements, Mr. Hughes should have entered on an investigation into the correctness or falsity of his first suppositions in the chapter, "Influence of the nature and form of the conductor upon its self-induction" of his second paper.

This, however, he did not do; he only states that his two methods have given him perfectly different results:—

"I suspected that there might be some difference in the non-magnetic metals independent of their specific resistance. For this purpose I made a series of experiments with wires of the same length and diameter,

but with different resistance. These showed a marked difference provided the current was increased in proportion to its diameter or conductivity, but no difference could be found when the current was kept a constant and the interior differences in resistance of the wires were compensated by an external resistance." . . . .

"If thin strips of copper, brass, lead and German silver are compared with similar iron strips and their resistance rendered equal by the added resistance in the bridge, no difference is found between iron and the non-magnetic metals, for under these conditions their inductive capacities appear equal." And says, concluding his second paper: "I have shown, thirdly, that the inductive capacities of different metals depends on their specific resistance."

Had Mr. Hughes treated the results of his first researches in a correct manner, making use of the formula which I developed in my critical remarks, he would have come to the conclusion that both ways of measurement give identical results, and that both methods affirm that there is no relation existent between the coefficient of self-induction and the physical nature of the non-magnetic metals.

In a like undecided manner Mr. Hughes expresses himself on the influence of the thickness of a wire upon the coefficient of self-induction. A faulty interpretation had led Mr. Hughes, in his first researches, to the erroneous result that the coefficient of self-induction was a complicated function of the wire thickness, growing to a maximum (which was very different from metal to metal) with the wire thickness and falling slowly from that point as the wire diameters were further increased. His second method gives Mr. Hughes *completely different results*. In spite of which he simply says:—

"I showed by the use of my late method a critical point in the rise and fall of the induced currents; this is not shown by the present method of compensating by external resistance, but the rapid decrease in the electromotive force of the induced currents is well shown by the present method. The following table shows the observed force of the currents for wires of the same length (1 metre), but of different diameters:—

	0·25 mm.	0·50 mm.	1 mm.	2 mm.	3 mm.	4 mm.	5 mm.	6 mm.	7 mm.	8 mm.	9 mm.	10 mm.
Iron ...	760	621	530	360	269	220	190	171	152	138	128	124
Copper	129	113	100	89	82	78	75	73	72	71·5	71·2	71

"The fall in force is now even more rapid than shown by my late method," and leaves the question, where lies the truth? completely on one side.

Had Mr. Hughes given himself the trouble to treat his earlier results according to the exact method developed by myself, he would have found that as regards the relation of the coefficients of self-induction of straight wires to their diameters, his two methods give one and the same result: that the coefficient of self-induction of such wires is expressed by the form

$$Q = 2\,l\left\{\log.\left(\frac{2\,l}{\rho}\right) - 0{\cdot}75\right\},$$

as long as the wire consists of a non-magnetic metal.

As Mr. Hughes has not in his new paper given proofs of the truth of his discoveries on the influence of the nature and form of conductors upon their self-induction, as he promised to do, I will add to these remarks in a somewhat explicit form several measurements executed by myself to prove anew the truth of my remarks. The results of these measurements show clearly that the discoveries of Mr. Hughes are the results of a false interpretation.

I will commence by a few remarks upon the method of measurement which was employed.

In his new researches Mr. Hughes departed from the former method and turned to a second, which he holds to be more efficacious for gaining exact results. In this I cannot quite agree with him. By means of this second method he arrives at *relative* values of the coefficients of self-induction. But in measurements of this kind, the method which gives us in a simple manner an *absolute* value for the dimension to be found will receive the preference. These absolute values may be obtained by means of Mr. Hughes's first method in an extremely simple way by submitting it to certain modifications.

The expression developed in my critical remarks

$$Q_1 = \pi_0 \,.\, \sin.\, v \left\{1 + \frac{w_1}{w_2} + \frac{w_1}{w_3} + \frac{w_1}{w_4}\right\}$$

$$+ Q_2 \frac{w_1}{w_2} + \frac{Q_3}{w_3} - \frac{Q_4}{w_4}$$

with which Mr. Hughes should have calculated his previous measurements to get correct values for the coefficients of self-induction, is so complicated that one can barely expect results of great exactitude from it, seeing that no less than nine values have to be measured for the determination of Q_1.

It further contains the supposition that one already knows the relation of the coefficient of self-induction of a straight wire to its form and dimensions, for the coefficients of self-induction of the three remaining sides of the Wheatstone quadrangle appear as parts in the expression of the coefficient to be determined. If, therefore, we regard, like Mr. Hughes, the relations of these coefficients to the size and form of the wires as unknown, we cannot arrive at the value of Q_1 in a simple way.

It is apparent that to attain a greater exactitude by means of this method, such modifications of the latter must be introduced as will simplify the expression for Q_1.

I have lately worked out several such simplifying modifications. One of these, which I have employed for measuring the small coefficients of self-induction of double-wound coils (see my paper, "Uber die Selbstinduction bifilar gewickelter Spiralen," Berichte der K. preuss. Academie der Wissenschaften in Berlin, 6 Mai, 1886) consists of the following arrangement:—

The conductor, A, B, of which the coefficient is to be determined, receives the form of a circular or rectangular plane loop; a and b being the two ends of this conductor. This plane loop is placed vertically, a and b occupying the highest position. At right angles to the loop and with a small distance between them is laid a pair of parallel thin German silver wires of the same length, thickness, and resistance; these we may call (3) and (4). Two ends of these wires (3) and (4) are soldered together at the point, D, the free ends, c, of (3) and d, of (4), are brought as near as possible to the ends, a and b, of the loop, A, B. Diametrically placed to this wire pair (3), (4), there is a second system (2), consisting, like the first, of two very thin German silver wires of the same length and thickness placed parallel, close together and normal to the loop, A, B. This second wire couple (2) is drawn through a small cylinder, filled with mercury, which may be slid at will, along the wires. The ends, e and f, of this couple which turns towards the ends of the loop, A, B, are brought to within a small distance a, b, c, d. Then the following connections are made between these six ends of the wires: b is joined to e, f to c, and lastly, d, with the commencement a, of the loop, A, B. The oscillating current enters this system at a and leaves it at c. The bridge wire which leads through the telephone has its one end in the point, D, its other end being in e, where the end, b, of the loop, A, B, is connected to the beginning of the wire pair (2).

By this arrangement it is possible to eliminate completely the effects of mutual induction between the wires of the system, with the exception of the mutual induction existing between the wires (3) and (4). This last, however, exerts no influence upon the result; in calculating the intensity of the current in the bridge we arrive at the same two equations of condition for the annulment of the current as were obtained for the general form of the method of Mr. Hughes:

$$0 = w_1\, w_4 - w_2\, w_3$$

$$0 = Q_1\, w_1 - Q_3\, w_2 + Q_4\, w_1 - Q_2\, w_3 - \pi\,(w_1 + w_2 + w_3 + w_4)$$

The nature of the arrangement described renders

$$w_3 = w_4$$
$$Q_3 = Q_4$$

and when, by variation of the resistance w_2 of the conductor (2) and by adjustment of the two coils the telephone has been silenced, then we have

$$Q_1 = Q_2 + \pi \left(2 + 2 \frac{w_1}{w_3} \right)$$

To further simplify this method, it is necessary to arrange matters so that Q_2 is reduced to such a small value that it is no more necessary to measure it very exactly. This may be attained by forming the side (2) of two very thin German silver wires laid parallel with a minimum of distance between them. Then a very small piece of the pair of wires (2) suffices to make $w_2 = w_1$; this short length, l_2, and the very small distance, a, between the two wires gives but a few centimetres for the value of Q_2. The number of these may easily be determined by means of the following formula:

$$Q_2 = 4 l_2 \left\{ \log. \left(\frac{a}{\rho_2} \right) + 0{\cdot}25 \right\}$$

Now, as the value of π may be calculated from the form, size and relative position of the two coils in absolute measure, we are enabled to find the *absolute* value of Q_1. We have

$$\pi = 2 \pi^2 . \frac{R_2^2}{R_1} . n_1 n_2 \left[1 + A \right] . \text{sin. } v = \pi_0 . \text{sin. } v,$$

n_1 and n_2, R_1 and R_2 standing for the numbers of windings and the mean radii of the respective coils, v being the angle formed by their axes. A is a small value dependent upon n_1 R_1, R_2 and the dimensions of the grooves which contain the windings, the form of which I will not develop here.

By this method I have during the past months executed a number of measurements of the coefficients of self-induction of conductors of different forms and substances. I will for the present cite only two series of these measurements: the one series I give to decide the question as to whether there is any relation existing between the physical nature and the coefficient of self-induction of non-magnetic metals; and the second series to show in what manner the coefficient of self-induction of wires of constant length, but variable thickness, depends upon the diameter.

In the first series the central line of the wires under examination had a *circular* form; in the second series, however, it formed a *square*.

The results given in the first table make it perfectly evident that it is not possible to observe any influence exerted by the nature of the non-magnetic metals upon their coefficient of self-induction.

The second series lays the fact clearly before us that the coefficient of self-induction of a non-magnetic metal wire depends upon the thickness of the wire in the very same form as is given by electro-dynamics.

The question regarding the influence of the nature and form of a non-magnetic metal upon the coefficient of self-induction is of fundamental importance in electro-dynamics. In contrast, therefore, to the somewhat uncertain position taken by Mr. Hughes in his last paper regarding this question, I will here denote my views on the same object most clearly.

I believe it to be proved that, firstly, the physical nature of non-magnetic metallic conductors has no sensible influence upon the coefficient of self-induction; that, secondly, the coefficients of self-induction of wires of these metals stand in such relation to their length, l, and the radius, ρ, of the wire section, as is expressed by the forms

$$Q = 2 l \left\{ \log. \left(\frac{l}{\rho} \right) - 0{\cdot}057 \right\} \text{ for a straight wire,}$$

$$Q = 2 l \left\{ \log. \left(\frac{l}{\rho} \right) - 1{\cdot}508 \right\} \text{ for a circular bent wire,}$$

$$Q = 2 l \left\{ \log. \left(\frac{l}{\rho} \right) - 1{\cdot}901 \right\} \text{ for a wire square,}$$

and that, thirdly, the differing results obtained by Mr. Hughes must be regarded as products of an incorrect interpretation of the data of his measurements.

Electrical Laboratory of the Polytechnikum,
Zürich, *June 25th*, 1886.

TABLE I.

Absolute Values of the Coefficients of Self-induction of Wires of Six different Non-magnetic Metals in the form of a circular loop of 1 m. diameter.

l signifies the length, ρ the radius of the wire section, Q_1' the coefficient of self induction calculated from the formula:

$$Q_1' = 2 l \left\{ \log. \left(\frac{l}{\rho} \right) - 1{\cdot}508 \right\}$$

and Q_1 the same quantity calculated from the data of the experiments.

	$2l =$	$\rho =$	$Q_1' =$	sin. $v =$	$2 + 2\frac{w_1}{w_3} =$	π_0	Q_2	Q_1	$Q_1' - Q_1$
	cm.	cm.	cm.			cm.	cm.	cm.	cm.
Silver	628·5	0·0511	4488·9	0·1181	2·1286	17693	14·7	4462·4	+ 26·5
Copper	628·3	0·0486	4566·2	0·1201	2·1440	17693	17·1	4572·9	− 6·7
Zinc	628·4	0·0515	4530·5	0·1013	2·4860	17693	51·4	4508·0	+ 22·5
German silver ...	628·3	0·0500	4548·3	0·1128	2·2721	17693	31·5	4566·1	− 17·8
Lead	628·1	0·0441	4625·3	0·1151	2·2620	17693	29·1	4635·8	− 10·5
Platin.	628·3	0·0501	4546·9	0·1139	2·2368	17693	26·5	4534·1	+ 12·8

TABLE II.

Absolute Values of the Coefficients of Self-induction of Six Copper Wires of the same length, l, and the same quadrangular form, but with different diameters, 2 ρ.

Q_1' signifies the theoretical value: $Q_1' = 2 l \left\{ \log. \left(\frac{l}{\rho} \right) - 1{\cdot}901 \right\}$ of the coefficient of self-induction of such a wire, and Q_1 the same quantity calculated from the data of the measurements.

	l	ρ	Q_1'	Sin. v	$2 + 2\frac{w_1}{w_3}$	π_0	Q_2	Q_1	$Q_1' - Q$
	cm.	cm.	cm.			cm.	cm.	cm.	cm.
Wire I.	399·0	0·00760	7150·5	0·3243	2·2974	9512	67·0	7153·8	− 3·3
Wire II.	399·0	0·0187	6431·9	0·3040	2·2324	9512	10·9	6466·2	− 32·3
Wire III.	399·4	0·0496	5675·9	0·2832	2·1147	9512	12·1	5708·6	− 32·7
Wire IV.	399·2	0·0984	5108·9	0·2623	2·0311	9512	14·3	5081·9	+ 27·0
Wire V.	399·1	0·1655	4698·1	0·2434	2·0116	9512	8·5	4665·3	+ 32·8
Wire VI.	400·7	0·220	4486·9	0·2353	2·0058	9512	7·1	4496·4	− 9·5

SOME RECENT ADVANCES IN TELEPHONY.*

TEN years ago, writes Mr. Thomas D. Lockwood in the *Electrical World*, a meeting of the American Academy of Arts and Sciences was held in Boston, at which Alexander Graham Bell expounded his ideas upon the electric speaking telephone.

Prior to that date a patent had been issued to the same gentleman upon the same subject; a patent which many persons state they have since ascertained refers in no way whatever to the speaking telephone; a statement which many other persons, perhaps equally well informed, believe to be based upon a wish that such were the case.

The first line built between two distant points expressly for telephonic transmission was completed April 4th, 1877, and extended from the office of the electrical manufacturer, Mr. Chas. Williams, Jun., 109, Court Street, Boston, to his house in Somerville, a distance of about three miles.

May 1st, 1877, the first lease of telephones for private line service was effected; and in May, 1877, telephones were first operated upon the exchange plan through a switch board in the office of Mr. E. T. Holmes, 342, Washington Street, Boston; the sub-stations comprising a number of different offices connected with the Holmes burglar alarm system by wires converging to Mr. Holmes's office. For a number of years it was assumed that the exclusive field of usefulness for the telephone, like that of the average and proverbial specimen of charity, not only began, but also ended at home; that the local short line, or exchange service, was the only kind in which telephones could, or would be, practically used. Recent experience proves this assumption as hardly correct. The exchange, or central office service, it is true, is the more immediately practical and obvious utilisation, and it was natural that the American people should measurably fill that sphere of action before looking for others, inasmuch as that was the line of operation promising the most speedy pecuniary return for the outlay. Lines of from a few yards to a dozen miles in length have, however, been connected with exchanges, and these have in turn been supplemented, as occasion served, by what are technically termed extra-territorial lines—that is, lines connecting different exchange centres; and from 1879 to the present time it has been a regular practice to talk over such lines with comparative ease perhaps for an average distance of 40 or 50 miles. In some of the Western States it has been a common thing to converse by telephone over much greater distances by switching lines together, but not always with ease.

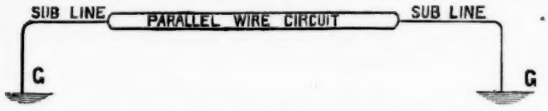


FIG. 1.—LONG DISTANCE TELEPHONE LINES.

I think it well understood now that three conditions have conspired to retard what is at present termed long-distance telephony. These are:

(*a*) The uncertainty of obtaining satisfactory and speedy reciprocal communication, and the consequent slowness of transmission, together with the inevitable result of such uncertainty, namely, the low prospective maximum capacity of remunerative transmission.

(*b*) The extreme noisiness of long lines, and increased telephonic induction, or cross talk, which in many cases renders the single or earth terminal circuit insufficient.

(*c*) The lack of transmitting instruments sufficiently powerful and trustworthy to develop voice currents capable of overriding the undesired currents and the noises produced thereby, and of sufficient E.M.F. and volume to affect the distant receiver with clearness and strength.

If it be asked at the present time, "What is long-line telephony?" I answer: "Telephonic communication over lines more than 50 and less than 500 miles long. Six years ago I should have limited it to lines between 20 and 50 miles long, and six years hereafter I may possibly fix the limits of long-line telephony between 250 and 1,500 miles. The term is purely comparative.

The most noteworthy advance of the telephone in the past few years has been in the direction of increasing the distance over which communication can be transmitted satisfactorily, and the advance which has been made is, I think, undoubtedly attributable to the introduction of copper line wire, and to the radical improvement of the transmitting telephone.

It must not be supposed that telephone communication over long lines was until recently entirely unknown, even when we accept the above definition of a long line.

On the contrary, it is a well authenticated fact that in the earliest days of the speaking telephone, time and space were well nigh obliterated.

In the remote period when the magneto speaking telephone was the only known—and was itself a new and wonderful thing—it was operated over lines of (for that time) really considerable length. On August 11th, 1876, for example, conversation was carried on at Brantford, Canada, between Brantford and Mount Pleasant, over five miles off, and on the succeeding day the length of line was increased to 10 miles.

As early as November 10th, 1876, a very long line was successfully used. I find among the early records of telephony the following statement:—"November 10th, 1876. We carried on a long conversation on the lines of the Eastern Railroad using part of the time a circuit from Boston to Salem (15 miles) and part of the time a circuit from Boston to North Conway and back to Salem, and from Boston to Portland and back, about 200 miles of actual wire.

This statement is made by Mr. Watson (who like De Sauty was long supposed to be a supposititious character, being always at the other end of the line) and is noticed in the Boston *Post*, *Globe*, *Advertiser*, and *Herald* of November 27th, 1876.

In the early spring of 1877, with a box and magneto-telephone, Mr. Bell, in New York, conversed with his associate in Boston on a Sunday, and he speaks of the occasion in the following words:

"The longest length of real telephone line through which I have attempted to converse has been about 250 miles.

"On this occasion no difficulty was experienced so long as parallel lines were not in operation. Sunday was chosen as the day on which it was probable other circuits would be at rest. Conversation was carried on between myself, in New York, and Mr. Thos. A. Watson, in Boston, until the opening of business upon the other wires. When this happened, the vocal sounds were very much diminished, but still audible.

"It seemed indeed like talking in a storm. Conversation, though possible, could be carried on with difficulty."

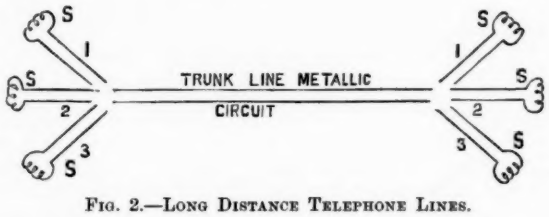


FIG. 2.—LONG DISTANCE TELEPHONE LINES.

There are, in fact, a number of such isolated cases, and I have thought proper to refer to these as showing that the idea at least is old, and that the magneto-telephone is not an utterly incapable instrument, even viewed as a transmitter. There is, however, a wide

* Read before the American Institute of Electrical Engineers, May 19th, 1886.

gulf between an occasional successful experiment, made under favourable conditions, in which experts can understand one another, and regular every day successful commercial communication.

If by recent developments this gulf has not been permanently and solidly bridged, there has at least been a convenient and useful ferry established.

Before leaving the early years of the telephone, it may amuse, if it does not instruct, to refer to an item which appeared in the *Scientific American* on November 29th, 1879, entitled "How far can we hear with the telephone?"

"This is a question frequently asked, but one which we believe has not yet been definitely settled. The longest distance that we have seen mentioned is given in the item below, namely, 2,000 miles. But perhaps Mr. Edison has had more extended experiences. If so, we should be glad if he would let our readers know. An exchange states that Mr. Robert A. Packer, superintendent of the Pennsylvania Railroad, is at present hunting with a party of gentlemen in Nebraska. A few days ago he for two hours conversed pleasantly with his wife and friends at Sayre, Pa., his brother at Mauch Chunk, Pa., and his friends along the line. The medium was the railroad and Western Union Telegraph wires, and Edison's telephone. At the office in Bethlehem, Pa., connection was made with the Easton and Amboy wire, and at Perth Amboy with a Western Union wire and thence to Chicago and North Bend, Neb., where the party are. The distance was about 2,000 miles and every whisper was audible."

Now if there is anything in the world that annoys one it is to hear an apparently trustworthy account of something being done in one's own special line of work which, with every appliance for the purpose, with experience and special education, we cannot do ourselves. It is not, therefore, speaking too strongly when I say that this statement both mystified and exasperated me, for I knew certainly that at that time I could not accomplish such a feat; but I possessed my soul in such patience as I could make available and awaited developments, having at least a suspicion that there might be an error in fact, seeing that the veracious chronicler had already committed himself to the statement that Mr. Packer's business relations were with the Pennsylvania Railroad instead of the New York and Pennsylvania Canal and Railroad Company, as it should

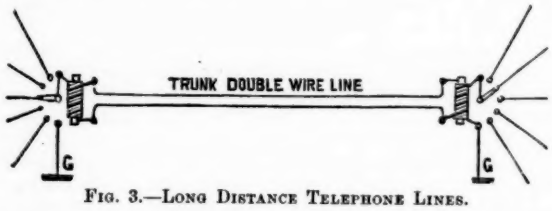


FIG. 3.—LONG DISTANCE TELEPHONE LINES.

have been. I had not long to wait, however. In the issue of December 27th, 1879, a second item appeared entitled "Long Range Telephoning" (I think the original one should have been called "Long Range Reporting) which read as follows:

"In a recent issue of this paper an exchange was credited with the statement that Mr. Robert Packer, while travelling in Nebraska, had conversed with his wife and friends at his home in Sayre, Pa., 2,000 miles distant, by means of a telephone. We now learn on good authority, that though Mr. Packer's friends received his communication by telephone it was not so sent by Mr. Packer. The message was sent from Nebraska to Mauch Chunk, Pa., by telegraph; thence it was telegraphed to the Sayre office of the Pennsylvania Canal and Railroad Company (of which Mr. Packer is superintendent) and from there it was transmitted to Mr. Packer's house by telephone, falling short of the newspaper report of the telephone's performance by some 1,999 miles and a fraction."

Such is a sample of the long-range telephony of 1879.

When in the summer of 1879 a telephone line of two wires was built between Boston and Lowell it was regarded as a great achievement, for it worked well. It, however, opened our eyes to the phenomenon of induction in another phase to that in which it had heretofore been made manifest, that phase, in fact, which in more recent times has been named "cross-talk."

We found that when conversation was transmitted upon either wire, it would be heard equally well upon the other at the receiving station, and until many other lines were built, it was found practically impossible to operate both lines at once.

This was the beginning of lines to connect distant telephone exchanges and the seed from which sprouted the long-line telephony of to-day. When, however, the value of copper as a material for line wire was recognised, the commercial feasibility of long-line telephony, as above defined, became a subject of serious consideration, and exchanges located 75, 100 and 150 miles apart, were brought into conversational proximity.

The possibilities of the telephone were never brought before my mind in so striking a manner as when I stood in a little room on Broadway in this city, and talked with a fellow mortal in Cleveland, Ohio. Many of the members of this Institute will doubtless remember that when the compound wire of the Postal Telegraph Company was built and communication over it completed in 1883, first to Cleveland, and later to Chicago, a noble army of telephonic patentees hastened to try their patented telephonic receivers and transmitters over it, and how each and all, after successfully exchanging words with the Western cities, went forth proclaiming to the world the unparalleled excellence of their special form of telephone.

When I first heard these statements I was firmly convinced that the achievements described were due not to any special excellence of the instruments employed, but to the greatly superior conductivity and insulation of the Postal wire over any other that had heretofore existed, and my conviction was intensified after I had had an opportunity to make the test myself and had found that not only could we make a Blake transmitter transmit speech which was perfectly reproduced at the receiving station, but that identical results could likewise be achieved with the magneto Bell telephone commonly used as a receiver.

To Mr. Thomas B. Doolittle, of Bridgeport, is due the credit of having first discerned the merits of copper as a material for telephone lines. A line of hard drawn copper was erected by that gentleman in November, 1877, in Ansonia, Conn., a section of which was taken down in August, 1884, and found to be, when compared with any iron wire of like age, in an excellent condition. I may also say that from the first moment of my acquaintance with Mr. Doolittle, I have found him a strong and persevering advocate of copper wire for telephone lines, and, considering our present views upon the relative merits of iron and copper, it is fair to say that I think he has made out his case and was considerably ahead of the times. My own fear was that it would prove too soft for common use, would not stand up, would expand under increase of temperature, and would fail to duly contract upon the resumption of normal temperatures. I had no doubt of its electrical merits.

The Postal wire, however, was electrically so far ahead of all expectation, telephonically considered, that it seemed to prove, once for all, that copper, if mechanically available, was decidedly the proper material to use, and it seemed also evident that if it would stand up alone it would be even more successful as a conductor, if the steel core were dispensed with.

Hard drawn copper wire was tried after being submitted to the various electrical and mechanical tests, and was not found wanting. In fact it promised well, and the result was the erection of an experimental line of two wires between New York and Boston, which worked satisfactorily, and with sufficient reliability to encourage its proprietors to build a line of a number of copper wires between New York and Philadelphia.

C

The experience gained in building, testing and operating the Boston line has been utilised in the more recent one, which is a model line in many respects.

When we began to use copper for this purpose, it was not easy to account for the comparative ease with which a line built of that material could be operated. It was attributed by many solely to the low specific resistance of copper, and I recollect instances where I have commented upon this remarkable point, and have been met with the remark, "Oh, it is only a question of resistance." But it was obvious that there was some more deep seated reason than the low specific resistance; for, if we take two lines of equal resistance, one built of copper and the other of iron, the copper is invariably by far the easier one to work.

This was, I confess, for a long time a problem to me, but has recently been wonderfully cleared up by the masterly researches of Prof. David E. Hughes, as detailed in his inaugural address, lately delivered before the Society of Telegraph Engineers and Electricians; with which every electrician interested in the communication of intelligence should familiarise himself.

His experiments showed that the E.M.F. of the extra current in a solid iron wire is much greater than in a similar copper wire; that ordinary copper wire has, with rapid currents, more than three times the resistance during actual work than that supposed to be its resistance (although with stranded iron and ordinary copper such is not the case), and that the extra current in wires furnished with a parallel return wire is much reduced; but much more in copper than in iron, viz., iron 15 per cent. and in copper 80 per cent.

It is also interesting to learn that the E.M.F. of the extra current in brass wire, compared with copper, is but as 13 to 20. This point may prove useful when a wire, stronger than copper, but of equal size, is at any time required.

These researches are so interesting and valuable that they gratify me nearly as much as though I myself had made them. I am aware that the statements of Prof. Hughes have been severely criticised by Prof. Weber and others, as was to be expected, but I am persuaded that his results will, in the main, be ultimately approved, and his views acquiesced in by the world of science; although it is very probable that some errors of detail may be found in them.

Approaching now advances made in instruments. I may say that it is noteworthy that nearly every improvement has been made in the transmitter. There are two good reasons for this. The first being that the receiving telephone came into existence well nigh as sensitive and perfect an instrument as it was possible to make it; and the second that in view of the noises, made apparent in the receiver on long lines, due to undesired currents, it was manifest that the transmitting power it was that required intensifying, to the end that it might be able to develop currents of sufficient strength to override the disturbing currents, and that if a transmitter of sufficient power could be made, it was even possible to reduce the sensitiveness of the receiver, and thus weaken the distributing noises by thickening the diaphragm, or by removing it to a greater distance from the magnet. The form of transmitter which has been found most successful is one in which granulated carbon in a loose and free state is employed as the current regulator. When first introduced it consisted simply of a handle, having a disc-shaped cavity cut in its face, the bottom of the cavity being faced with some suitable metal or alloy as copper, silver or brass.

The front of the chamber was closed by a piece of platinum foil, which served as a vibrating diaphragm, and the sides of the chamber were formed of the same non-conducting material as the body of the handle itself. The space between the back and front plates was partly filled with the carbon granulations, and the front plate protected by a mouth-piece. The instrument was then complete, and though exceedingly simple in construction, worked, and worked well. When in use, it was most efficient when held so that the diaphragm presented an angle of about 45° from the vertical position, the upper edge being inclined backward.

When this instrument was good, it was "very, very good," and like the little girl of the nursery rhyme, when it was bad, it was "horrid."

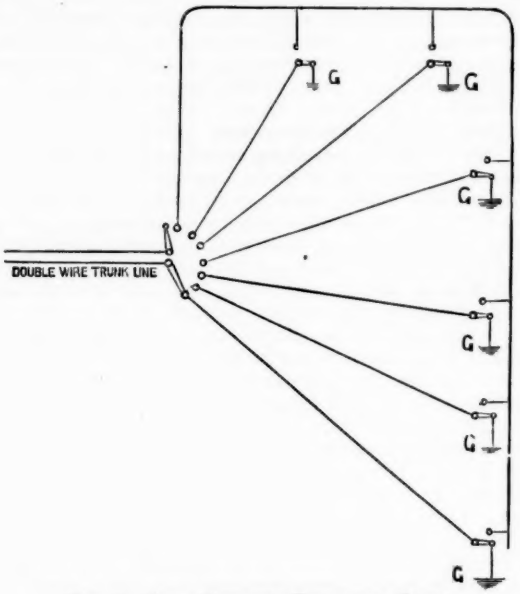


FIG. 4.—LONG DISTANCE TELEPHONE LINES.

It had one grave fault, the granulating powder would occasionally pack itself into a mass. and was then anything but as sensitive as it should be; under such circumstances it became a very poor transmitter. The customary remedy for this disease may be indicated by the familiar words of counsel invariably found upon the apothecary's label, "When taken, to be well shaken," and, when shaken, the sick transmitter would usually resume its duties. But an ounce of prophylactic is better than a pound of medicine, and the want was decidedly a transmitter equal to the Hunnings, but which would not pack.

The first step was the adoption of a horizontally mounted diaphragm, the speaking tube of which ended opposite to the lower face, and it was found that when the carbon granules were placed on the upper surface of this plate, the voice vibrations acted upon them with great force, and tended to loosen them if packing had begun. This was not, however, completely satisfactory. It was subsequently ascertained that the back plate should, to obtain the best results, lie buried in the mass of carbon which lay on the diaphragm, or should dip into the same in the form of a pendant, and that the resistance of the entire instrument should be reduced as much as possible.

One form, invented by Mr. Blake, employs for the complimentary, or back electrode, a metal sieve, which is buried in the mass of granular carbon. In another form the back electrode takes a form something like that of a shade roller pulley, and has a number of holes bored through it in different directions, so that the carbon granulations can freely circulate. In both cases it is found advantageous to plate the electrode with some unoxidisable metal, such as gold, and to form the diaphragm, as in the original Hunning's instrument, of platinum foil.

One of the circuit wires is united to the diaphragm, the other to the back electrode, and the mass of granulated carbon lies upon the former with the whole or a portion of the latter immersed, or buried in it. These transmitters give admirable results. The tone, volume of sound, and clearness of articulation developed by them is most encouraging, and by their use the range of long-distance telephony has already greatly expanded even on long, single iron wires. The distance that they can be efficiently operated has not

even yet been authoritatively ascertained, but, judging from the fact that instruments of the most inferior character can be made to maintain successful conversation between New York and Chicago over a compound wire, we are encouraged to believe that conversation can be easily transmitted over much greater distances than that by availing ourselves of the most improved forms of Hunnings's telephone. It is well known that long telephone lines are greatly troubled by the noises manifested in the receiver; these noises being due to magnetic or current induction, leakage from other wires, atmospheric and earth currents, and magneto-electric currents induced in them when they are blown about, and thus made to move across the magnetic lines of force of the earth.

It has been found necessary, in order to reduce these disturbances to a minimum, to adopt an old laboratory expedient, and to provide each line with a wire return as nearly as practicable equidistant with the direct wire from all known sources of disturbance, so that the disturbing currents, proceeding in the same direction on both sides of the circuit, will neutralise one another. But when we take such a double wire, we find that it is not easy to preserve its benefits, and at the same time to connect it with a short exchange line at both ends, for, if we take a parallel wire metallic circuit trunk line and connect it with a short subscriber's single wire line by absolute contact, as in fig. 1, it is obvious that we have lost the basis of neutralisation, and only gained a conductor of lower resistance.

There are two plans from which we may choose. We may run a double wire to each subscriber wishing to use the long line facilities, as in fig. 2, in which case the problem is at once solved; for, when we unite the two terminals of the subscriber's short loop line with the two wires of the long trunk line, we have simply extended the said trunk line half a mile or a mile, or whatever distance it may be, further.

This plan, however, presents some disadvantages, in that it necessitates a double wire for each subscriber's line, and the concomitant changes in apparatus at the central station; and it is, after all, rather an inordinate expense to incur, when the subscriber may possibly only use the long line once a month.

The alternative plan is to employ repeating translating coils. These are really induction coils of peculiar construction, the two circuits of which are made much nearer each other in the size of wire and resistance than is usual in the ordinary coil.

One of these circuits—that which is composed of the finest wire, and which is wound to the highest resistance—is connected in circuit with the two ends of the long metallic circuit trunk line, while the remaining coil has one terminal, united to the single central station end of the subscriber's line, and the other attached to a ground wire. This arrangement is shown in fig. 3, in which one terminal of the local side of the coil is represented as being united with a button switch by which it may be connected with any desired subscriber's line. The beneficial results of the neutralisation of the disturbing currents are thus obtained, these being at least minimised by means of the return wire; while the telephonic currents induce currents of like character in the coil which is in circuit with the shorter and local line, thereby reproducing the transmitted speech in the receiving telephones connected therewith.

The reason for making the two circuits of these translating coils so much more nearly equal in character and conductivity than are those of the ordinary induction coil, is that each is in turn the inducing and induced circuit—that is, the conversation is transmitted from the long trunk line to the short subscriber's line, as well as from the short line to the long metallic circuit. Each is therefore required to exercise the functions of both primary and secondary coil. I have every reason to believe that the first instance of the use of an induction c il in this capacity was by Mr. Thomas Watson and myself, in September, 1879, immediately after the completion of the two lines between Boston and Lowell.

We used the two lines between the cities as a trunk metallic circuit, and by means of two induction coils, one at each end, two exchange lines were inductively connected with the main line. I operated the ground circuit at Lowell, Mr. Watson engineered the induction coil at the Boston Exchange, and Mr. Theo. N. Vail was at his own office in Boston, and talked with me through two induction coils.

The coils we then used were wound with both circuits approximately equal, about 250 ohms each, and were wound together from beginning to end, two wires being wound on the spool at the same time, a mode of construction which, by the way, experience has, I think, demonstrated to be the most satisfactory for inductoria intended for this purpose, and which will probably be adopted.

It is proper to note that we were led to this idea by considering the mode of using the transmitter induction coil, which was even then well known; this use, however, though analogous is not identical, for it must be remembered that in the transmitter coil the iron core is maintained during action in a state of magnetic polarisation by the battery currents, whereas the currents, traversing the surrounding circuits of the translating coil, have not sufficient strength to effect such a state in the core, and the induction of these coils is, therefore, almost entirely current induction of one of the coil wires upon the other, the magnetic reactions between coil and core being necessarily trifling in character. The induced effects may, however, be intensified by separately magnetising the core, either by a separate battery coil or by a permanent magnet, and I have sometimes done this with advantage.

A third plan whereby the double line may be conveniently connected with any one of a number of short grounded lines, without depriving it of any of its virtue, has been patented by Mr. Geo. H. Bliss.

This is indicated in the diagram, fig. 4. It consists in extending from the central station an additional line wire which may branch into as many sub-stations as are intended to use the long double wire trunk line. Each of these sub-stations may be fitted with a button switch which, when turned in one direction, will retain the telephones in their ordinary ground circuit, but which, when turned reversely, will disconnect the subscriber's line from its ordinary earth terminal and unite it with the branch from this extra circuit, thus providing a double, although not a parallel, wire between the central and sub-station, both ends of which may be then united with the two ends of the metallic circuit trunk line.

One extra wire of somewhat abnormal length is thus enabled to serve in place of a great number. It would be easy to fit the telephone call boxes with a double gravity switch and two separate telephone receivers, one on each side of the bell box, and to so connect these switches with the circuits that it might be invariably understood that when the receiving telephone on one side is taken from its place and used, the line would be used in its normal condition, but that the other telephone, when taken up, would connect itself and the transmitter in the loop circuit. One could then be always used for short line and the other for long-line work. I am very favourably impressed with this, and do not believe that it has yet had the trial it deserves.

I am conscious that this paper already is too long. I may not, therefore, on this occasion describe at length the specialities in switching and signalling appliances which have been found necessary, and have consequently developed in the practice of long-line telephony, but hope either to say or listen to something of this branch at some future time.

I have, I think, said enough to prove that long-line telephony is a reality, the New York *Times* on contract obligations to the contrary notwithstanding.

Electric Light in Theatres.—During the forthcoming performances of Wagner's compositions at Bayreuth, the theatre will be illuminated by the electric light.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 13.)

Friday, May 14th, 1886.

THE SOLICITOR-GENERAL continuing his address for the defence, said: My Lord, I propose to sum up the slight historical sketch which I troubled your lordship with yesterday afternoon in this way. I will suppose that King had made his lamp. He tells us that his lamp is to be made with as perfect a vacuum as possible, and he is aware of the necessity, or, at any rate, expediency of obtaining a conductor of high resistance. He proposes to use carbon conductors, without confining himself to any size, or defining whether it is a rod, or stating what is the material, whether it is cut out of a piece of carbon (although he states one mode in which it may be made in that way), or whether it is made in any other form. He finds that his vacuum is not as perfect as it can be made. I will then suppose that a person applies a vacuum produced by Sprengel's pump, after the invention of that instrument, as he would have a perfect right to do, and substitutes a vacuum obtained by means of the Sprengel's pump for the Torricellian vacuum. I will then suppose that the person knows, as of course every person who is engaged in the manufacture of these lamps does know, the scientific law relating to resistance. He is aware that high resistance is necessary to the success of his lamp; I will suppose that he knows the law by which high resistance is to be obtained. If he did not know it before, he will find it accurately and concisely stated in Mr. Lane-Fox's patent, that law being—I am not certain that I express it with scientific accuracy, but, I believe, with sufficient practical accuracy, when I say that the resistance of the conductor varies inversely with the sectional area of the conductor. I will suppose that he is aware of that. What does he do? He wants high resistance, and he reduces the sectional area of his conductor, and he has a perfect right to do it. He has got, therefore, his vacuum; he has substituted his vacuum obtained by the Sprengel pump for his Torricellian vacuum. King tells us in his patent that you must obtain the most complete vacuum you can, and therefore a person would be entitled to use the known scientific means of obtaining that most complete vacuum. It is quite true that Sprengel's pump was not invented in that day, but of course a person would be entitled to use the best known means of obtaining that which King tells us you ought to obtain—as complete a vacuum as possible. He then knows that he wants high resistance; and he tells us how that high resistance is to be obtained, by reducing the sectional area. He has got a patent for carbon conductors of all kinds; he then looks about for some carbon conductor which will satisfy that condition of having a small sectional area. The witnesses told us that carbonising threads and converting them into filaments of carbon was well known long before the date of Edison's patent. Sir Frederick Bramwell and all the scientific gentlemen who have given evidence before your lordship agree in that. In fact, Sir Frederick Bramwell scouted the idea of there being any novelty whatever in carbonising a thread of hemp, silk, or anything else, in a closed chamber. He knows, therefore, that you may obtain a carbon conductor by means of carbonising thread in a closed chamber. But if he did not know that which was matter of common scientific knowledge he might have gone to Sidot. Now in Sidot he will find a description by which, as our witnesses will show your lordship, a most beautiful carbon conductor can be obtained. I should not trust entirely to my own suppositions and to my own suggestions, although I think those suggestions are justified by the evidence which is before your lordship, but I will read one passage from the evidence of Dr. Fleming, on page 3 on the third day. I asked him, at question 812, "I ask you if any one, following Sidot's directions, treated threads of cotton, hemp, paper, or silk, in the manner described in this paper, would he not obtain a carbon filament?—(A.) I think he would. (Q.) Suppose Swan had put one of Sidot's carbon filaments into his lamp, is there anything to prevent his doing that?—(A.) I know of nothing to prevent him doing it. (Q.) If he was aware of Sidot's paper?—(A.) Yes. (Q.) Would you not then have had a lamp that, according to your own description, would come within Edison's second claim?—(A.) I think it would." Now, my lord, I am perfectly aware of what Prof. Dewar said yesterday. I was not present, but I had the means of informing myself of what he said, and I am perfectly aware that Prof. Dewar said yesterday that he had tried Sidot's method of making a carbon filament and had found it a failure. Well, my lord, we all have the greatest respect for Prof. Dewar as a man of science.

MR. JUSTICE BUTT: I understood him to say, "I tried it and found it resulted in exactly what Sidot described, and that is a filament."

THE SOLICITOR-GENERAL: He produced a thing which he said was full of unevennesses and irregularities, and was not suitable, as I understand, for the purpose.

MR. JUSTICE BUTT: What he said was, what Sidot describes in his paper.

THE SOLICITOR-GENERAL: You could not have a more signal instance of a gentleman—I do not say designedly and deliberately, but with a bias which, I suppose, every expert witness is supposed to have of supporting the side which he appears to support. You could not have a more signal instance of trying how not to do it, because it is plain that so far from following Sidot's directions, he disregarded them. Now, my lord, Prof. Dewar told us that he had done Sidot's operation. But how did he do it? In the first place he took a thread which was already carbonised. Sidot tells us, you are to take a piece of wood not carbonised, and, he says, you are to take a thread of hemp, silk, or other materials which he mentions, not carbonised. That is the first way in which he departed from Sidot's directions. Sidot did it with a piece of wood in its natural state. Sidot tells you that you ought to use disulphide of carbon. Prof. Dewar used benzol. Now, my lord, evidence will be given to you that benzol differs from disulphide of carbon in these respects, that it is far richer in carbon than disulphide of carbon, and that it is more easily decomposable. I am instructed, and of course it will be a matter of evidence, that benzol contains 92·3 per cent. of carbon, whereas disulphide of carbon contains only 15·8 per cent. of carbon, and therefore he took a substance which was richer in carbon and consequently more easily decomposable by the action of heat than the substance, or liquid or vapour, or whatever may be the way of describing it, which Sidot experimented with, namely, disulphide of carbon. Then, my lord, in order to make the experiment more unsuccessful, whereas Sidot tells you that he exposed his wood in disulphide of carbon to the action of heat for one hour, Prof. Dewar exposed it for nearly three hours, that is to say for nearly three times the time which Sidot mentions. Now, my lord, is it any wonder that he did not succeed in producing a useful filament of carbon?

MR. JUSTICE BUTT: I do not know whether I rightly understood it, but, as I understood it, his point was, I produced practically the same thing that Sidot describes in his paper, namely, a filament formed of what he calls *petites boules*.

THE SOLICITOR-GENERAL: No, the *petites boules* is as to those natural filaments which are formed on the sides of retorts. That is a different thing. I am mentioning the first process which Sidot refers to.

MR. ASTON: He showed them on the ground as well.

THE SOLICITOR-GENERAL: Sidot says this: "I introduce into a porcelain tube little pieces of wood across which I begin by passing the vapour of carbon disulphide in a cold state in order to expel all the air of the tube." Pausing there, Prof. Dewar says that he introduced into a porcelain tube, not little pieces of wood in their natural state, but little pieces of wood which were already carbonised, and instead of passing the vapour of carbon disulphide in a cold state in order to expel all the air of the tube, he passed the vapour of benzol, which I am instructed is richer in carbon to the extent I mentioned and is also more easily decomposed by the action of heat. "The first result being obtained, I heat the tube slowly and gradually up to a great heat for the space of about an hour." Prof. Dewar says he heated it for the space of nearly three hours. Then Sidot tells you that he has obtained similar results with threads of other kinds. Instead of obtaining a useful carbon filament by treating his thread in this way, he deposited masses of carbon on an already carbonised filament. That is not Sidot's process, and I shall call two witnesses before you—at least I am so instructed—who have performed the experiments in exact accordance with the directions given by Sidot, and who will produce to your lordship the carbon filament which is the result of following Sidot's instructions. Now, my lord, the reason why Prof. Dewar failed is not difficult to see. In the first place, his material was richer in carbon and more easily decomposable, and therefore it would require, not more time, but less time in order to obtain the deposit of carbon. But instead of taking less time, he took nearly three times longer, the result of which was that he got a deposit of masses of carbon upon an already carbonised filament.

MR. MOULTON: With regard to benzol being used instead of disulphide of carbon, that was under the last paragraph, which speaks of carburetted hydrogen, and he also said it would make no difference. The translation is wrong on that point. If your lordship will look at the title, it is "The action of disulphide of hydrogen and carburetted gases on wood charcoal," so that it was not a mistake to use benzol for disulphide of carbon.

THE SOLICITOR-GENERAL: I can quite understand that Mr. Moulton feels the pressure of what I am saying and therefore interrupted me in a most irregular manner; but I believe I am absolutely accurate in saying that Prof. Dewar did treat a piece of carbonised wood instead of a piece of wood in its natural state, as directed by Sidot, with benzol carbon instead of disulphide of carbon, which is the material in vapour with which Sidot says he tried his experiments; that he did treat it for nearly three hours instead of one hour. My comments may be all wrong; my witnesses may not bear out what I have said; but I repeat what I said, that he did depart from the directions given by Sidot, and that it is no wonder that he failed in his experiments. Then on page 152 of the shorthand notes of yesterday, your lordship says: "I have got it down that he produced a thread by Sidot's process from thread already carbonised. (Mr. Charles): What hydro-carbon did you use?—(A.) Yesterday I used benzol vapour. (Q.) Is that a very highly carbonised hydro-carbon?—(A.) Yes, it contains a very considerable quantity of carbon. He does not mention any hydro-carbon. He says hydro-carbons generally. Paraffin oil would have been the same thing."

MR. MOULTON: I submit that you are misrepresenting that evidence. Disulphide of carbon is not hydro-carbon at all. The professor was dealing with the last paragraph of Sidot.

Mr. JUSTICE BUTT: The Solicitor-General says he was not, and I am not clear that he was, at present.

The SOLICITOR-GENERAL: All I can say is, if that is so, Prof. Dewar was not dealing with the first process, and the thing remains perfectly untouched by evidence.

Mr. JUSTICE BUTT: What occurred to me, Mr. Solicitor, was that you would have relied rather on the filament produced by the last process.

The SOLICITOR-GENERAL: Oh, no.

Mr. JUSTICE BUTT: Then I quite understand your point. The thing that you rely upon mainly is that which is set forth as being produced in the paragraph commencing "Pencils made from this."

The SOLICITOR-GENERAL: We rely upon both. He describes his process in the words which I have already read to your lordship. "When it has cooled, we find in the tube sticks of a carbon differing in their physical properties from ordinary carbon. The substances of the most different woods, such as box, ash, elm, elder and cork can make this new carbon. What especially distinguishes it is its ringing sound," and so forth; and that, I may mention, is one of the peculiarities, or one of the qualities, which they attribute to their carbon filaments. Then: "The same carbons which are distinguished so completely by their elasticity from ordinary carbons, differ also from these last in their great conductibility for heat and electricity. I believe that they would perhaps replace the carbons of the Bunsen battery. Pencils made from this give a much more intense electric light than that which we obtain from gas retort carbon." That is what I am referring to, and if my learned friend says that is inaccurate, if he will forgive me for saying so, he will have ample opportunity of cross-examining my witnesses on the point. I may be quite wrong, and my witnesses may be quite wrong, but for what it is worth I tell your lordship what I am going to prove. I am going to prove by scientific gentlemen, whose competency to perform the experiment will not be matter of dispute, that by following exactly the directions given by Sidot they produced a beautiful carbon filament which is capable of being applied, and they will tell you that it is an excellent carbon filament for the purpose of being used as a conductor in an incandescent lamp. Whether my learned friend says this does not relate to Sidot's first process or not, is perfectly immaterial. If it did not, the result is this, that he has not tried that first process at all. The evidence that I shall give yon will therefore not be in conflict with anything Prof. Dewar has said. If he did refer to the first process, then I have opened to your lordship the grounds on which, I am instructed, my scientific witnesses will say the experiment failed. And, my lord, if I may give you an illustration, it is very much as if a person proceeded to electrotype a spoon. In order to electrotype a spoon with success you must take care not to lay on too much metal, you must take care not to expose the spoon too long to the liquid in which it is placed for the purpose of electrotyping. If you do, you produce an irregular, rough surface, and not that beautiful smooth surface which is produced by electrotyping when it is properly conducted; and of course you must not use too strong a battery, and so forth. But, my lord, I do not care very much about this, because the only point I wish to bring to your lordship's attention at the present moment is this, that all the witnesses agree that producing the carbon filament by carbonising the thread in a closed chamber was not a novelty, and was well known to everybody. Therefore, if a person wished to obtain a carbon conductor, it was perfectly open to him to use a material which was perfectly well known to scientific men and amongst persons practically engaged. Now, I will go back to what I was saying. I take Mr. King's lamp. I substitute a vacuum obtained by Sprengel's pump for the Torricellian vacuum as the best known scientific means subsequently discovered to King's patent for producing what he desired, namely, as complete a vacuum as possible. He does not confine himself to carbon conductors of any kind; he is aware that high resistance is necessary; he is aware that the means of obtaining high resistance is to reduce the sectional area of your carbon conductor. Swan's lamp your lordship has before you. In Swan's lamp you have all the elements of Edison's second claim, with this difference. My learned friends choose to describe the conductor in that as a carbon pencil and not a carbon filament. Now what is Edison's second claim? Edison's second claim, according to the construction which has now been put upon it, is a claim pure and simple for the substitution of a carbon filament for a carbon pencil. If you put a carbon filament into Swan's lamp, say the witnesses, you will have an Edison lamp. Therefore, putting it in its strictest and fairest form, the second claim is for nothing more than the substitution of a carbon filament for a carbon pencil. Dr. Fleming told us, for instance, that if you put one of these carbons obtained by Sidot's process into Swan's lamp, as it was perfectly open for any person to do, you would obtain an Edison lamp. Therefore, the important question now arises, what is a pencil? what is a filament? and that really seems to be the whole of this case. My learned friends have come into court for the purpose of maintaining a monopoly of incandescent lamps on the difference between a filament and a pencil. Where does a pencil cease to be a pencil, and where does a filament begin to be a filament?

Mr. JUSTICE BUTT: As a matter of fact, Mr. Solicitor, are what have been described as carbon sticks or carbon pencils in any of these patents or specifications, bent, or were they straight sticks.

The SOLICITOR-GENERAL: In no single one of those patents is any particular form claimed for the carbon conductor. It would be equally within King's patent to use one in the shape of an arch as to use one which was straight, and it would be equally within Roberts's patent to have used his piece of carbon in any shape that he thought fit. My point is this, that Edison's second claim is too large, as we are now told to construe it.

Mr. JUSTICE BUTT: If a filament is capable of being bent and a pencil is not, there may be a broad distinction between the two. I do not at all say that it is so.

The SOLICITOR-GENERAL: If Edison had told us that he confined his carbon filament to a filament which was capable of being bent into the shape of an arch, that observation, if I may respectfully say so, would have been very pertinent. But he does not; he includes all carbon filaments, that is to say, of whatever shape or size or construction, everything that can be described as a carbon filament. Now I turn to a work of some authority, Roget's "Thesaurus of English Words and Phrases, classified and arranged so as to facilitate the expression of ideas and words in literary composition." I suppose specifications are literary compositions. I do not mean to allege that they are always perfect models of composition, but they are included in literary composition, I suppose. Now, what he says of filament is: "Filament, lime, fibre, fibril, funicle, vein, hair, capillament, cilium, tendril, gossamer, hair-stroke, wire, string, thread, pack-thread, cotton, sewing-silk, twine, twist, whip-cord, tape, ribbon, cord, rope, yarn, hemp, oakum, jute." Those are all given as synonymous with filament. A filament, therefore, means, to use the language which has been used by the witnesses, an elongated material of small sectional area. Now, my lord, where does filament begin? I have a piece of silk to which my eyeglass is attached, which is rather larger than the dimensions of the lead of a fine lead pencil, rather larger than the dimensions of Swan's carbon conductor. Suppose I cut off a piece of this and carbonise it in a closed chamber, would that be a filament?

Mr. ASTON: Yes.

The SOLICITOR-GENERAL: My learned friend says yes; but it is of considerably larger sectional area than the carbon conductor in Swan's lamp. Where does filament begin? at what sectional area?

Mr. JUSTICE BUTT: If you attach your eyeglass to a pencil you would find a difficulty, because it will not bend.

The SOLICITOR-GENERAL: For the purpose of attaching an eyeglass it is quite true; but I am not aware that any place has been pointed out that says it is necessary to have a filament that will bend.

Mr. JUSTICE BUTT: Is not Roget's last paragraph descriptive of everything that is flexible in a high degree? Everything is flexible, more or less, but are not all those instances of materials which are in a high degree flexible?

The SOLICITOR-GENERAL: They vary infinitely, because one of the things is jute.

Mr. JUSTICE BUTT: Jute is very flexible.

The SOLICITOR-GENERAL: They vary. One of the instances given by Edison himself is a splint of wood. Supposing I take a twig of a tree and carbonise it, is that a carbon filament? Suppose I cut it in two, or split it lengthwise and divide it into two and carbonise the two separate pieces, are those filaments?

Mr. JUSTICE BUTT: I presume the splint of wood is more flexible when carbonised?

The SOLICITOR-GENERAL: No, it is less flexible after carbonisation.

Mr. JUSTICE BUTT: Usually things would be so, as thread, but is that so with a splint of wood?

The SOLICITOR-GENERAL: Mr. Imray having misunderstood Sir Richard Webster in the same way that I did, that it was part of their case that shape should be given to it before carbonisation, he said it should be a material that should be flexible before carbonisation, capable of receiving a shape before carbonisation and of retaining it after carbonisation. I believe I am correct in saying that it loses its flexibility after carbonisation.

Mr. JUSTICE BUTT: I suppose most things would.

The SOLICITOR-GENERAL:—I should infer it from the mode in which he describes his spiral, because one of the ways in which he makes his spiral is before it is carbonised to introduce a copper wire into it to give it consistency and to enable it to retain its shape. But, my lord, I will now refer to what the witnesses who were called by my learned friends say that a filament consists of. I will take an unexceptionable witness, Dr. Hopkinson. He is examined by Sir Richard Webster: "Speaking as a scientific gentleman only, and considering the contents of Edison's specification 4576, would you just tell his lordship what in your opinion is the electrical combination there described?—(A.) The electrical combination is a conductor of carbon of small cross-section, consequently of comparatively high resistance, and properly called a filament, and prepared in a particular way." That we have now got rid of; but he defines it as a conductor of carbon with small cross-section. Then he is asked: "In addition do you find any special mode of construction or shape of the carbon conductor?—(A.) I think I said that the filament was to be made in a particular way which the patentee describes." There the only peculiarity which Dr. Hopkinson gives to a filament is that of being of small cross-section. Later Sir Richard Webster asks him: "You are aware that the flexibility of the filament before carbonisation is spoken of by Mr. Edison in his specification?—(A.) I do not remember whether he puts it in those terms, but it is implied." Dr. Hopkinson was more accurate than my learned friend. "Does that flexibility continue after it has been carbonised?—(A.) Yes, but in a less degree." So that I was not inaccurate in what I said. In cross-examination by Mr. Charles he is asked: "Now with reference

to the word filament. If I understood your answer to Sir Richard Webster, you do not consider that that substance inside the Swan lamp is a filament?—(A.) No. (Q.) Then do you confine the word filament to thin wire, or thinner wire than that, or what?—(A.) I am not prepared to say the precise dimensions at which a filament begins, but I understand the word filament to be used for the purpose of calling attention to the smallness of the cross-section which is desired in comparison with the length." I do not at all dissent from that, but I call your attention to this, that in the view of Dr. Hopkinson—and I need scarcely say you could not have a gentleman of higher scientific attainments—he understands the word filament to be used for the purpose of calling attention to the smallness of the cross-section which is desired in comparison with the length. Further on, he is asked, "Where do you stop calling a thin substance a filament? Is it a matter of degree?—(A.) It is a mere matter of degree." Your lordship asks, "Mr. Swan calls that identical thing in the lamp you have before you a filament. Do you agree with him that it is properly called a filament?—(A.) Certainly not. (Q.) If not, why not?—(A.) Because the section is comparatively considerable as compared with anything I have ever heard the term filament applied to. There is no sensible degree of flexibility about it." So we had it from Dr. Hopkinson that it is a mere question of degree, that he cannot—and one is not surprised at that—see when the thing begins to be a filament and when it ceases to be a filament. Dr. Fleming was called on the following day; Dr. Fleming, I should remind your lordship, introduced the ideas of flexibility and elasticity—I do not know where he gets the elasticity from—into the idea of a filament. In cross-examination I said to him: "The primary meaning of filament, you would agree with me, is that of a thread, or as you have more accurately described it, an elongated material of small sectional area?—(A.) Yes. (Q.) The point being the small sectional area?—(A.) Yes. (Q.) So that the primary distinction between a filament and a pencil would be the comparative sectional area?—(A.) I think so. (Q.) With regard to a thread, you would agree that a thread would admit of all degrees of elasticity?—(A.) Certainly. (Q.) You may have a non-elastic thread, may you not?—(A.) I do not recollect ever having seen one. (Q.) Supposing one of the fibrous vegetable materials would be a bit of wood. That would vary much in rigidity from other fibrous materials you can suggest, would it not?—(A.) Certainly. (Q.) So that there are all degrees of rigidity and elasticity which would come under your description of a filament?—(A.) Yes." Well, my lord, if you make a very thin material it will necessarily be flexible. We did not require Dr. Hopkinson or Dr. Fleming to tell us that; but they all agree in this, that it is a mere matter of degree, that you cannot draw the line between what is a filament and what is not a filament.

Mr. JUSTICE BUTT: What has been passing in my mind is that you run them all into a difficulty, and you are perfectly entitled to use it; but to an unscientific mind there does appear to be a difference between a filament and a pencil other than that. I cannot understand the cross-examination on it any more than those gentlemen can.

The SOLICITOR GENERAL: I am quite content. I do not know whether I have made it clear to your lordship's mind, but in previous patents to which reference has been made, carbon conductors generally are spoken of, and it was perfectly open to any gentleman making his lamp to make carbon conductors of elasticity and flexibility or rigidity. Not one of them even confines himself to a rigid carbon, or one which was more or less rigid or elastic. Take, for instance, Scott's and Van Choate's ribbon. Scott's ribbon, I quite agree, was described for the purpose of the arc lamp, but it is a pure carbon ribbon or thread.

Mr. JUSTICE BUTT: Is it Scott's patent which speaks of ribbon so thin that if you lay the ribbon over writing you can read the writing?

The SOLICITOR-GENERAL: No; that was King. Scott describes it as a wire, and calls it a band, strip or ribbon, without giving any dimensions. Mr. Imray told me that Scott's ribbon forms a very good conductor, and would be a filament. Now, I have got to this, that Edison's second claim is the substitution of a filament for a pencil, if you please. But I think that is not perfectly accurate, because my point is this, that carbon conductors generally, without reference to size, material or shape, or flexibility, were matters which had been described, that all the world were entitled to use carbon conductors, that all the world—or, at any rate, all the scientific and practical world—knew means by which carbon conductors could be made of a thin sectional area. A person cannot take out a patent and obtain a monopoly for using a particular kind of carbon conductor, unless his invention consists in a mode of preparing that carbon conductor. Of course, if you have a patent such as Edison's later patent for a particular mode of preparing a carbon filament, say by punching out strips of Bristol board, charring or carbonising them in a closed chamber in a particular manner—that if it is new, would be a perfectly good patent. But supposing all the world has the right to use carbon conductors generally, a man cannot obtain a monopoly for a particular kind of carbon conductor which is not new in itself, although that particular kind of carbon conductor may give particular advantages. He cannot by merely pointing out a special advantage which a particular kind of carbon conductor may have—a well-known carbon conductor—obtain for himself a monopoly. I will give my friend the benefit for the present moment of elasticity and flexibility, because I do not want to confuse the argument I am addressing to your lordship. It is nothing more than a practical direction to a manufacturer of lamps—a practical direction, say to Swan; if you reduce the cross-section of your carbon conductor and make it of some well-known material which is more flexible than other species of carbon, you will obtain particular advantages. That is not the proper subject of a patent, and there is no novelty in it. If I am right in saying that the use of carbon conductors in a vacuum attached to platinum wires was well-known, it is not the proper subject matter of a patent, and there is no novelty for a man to claim the use of a particular kind of carbon conductor unless he describes a new mode of making that carbon conductor. There is a great deal of authority upon this point. In other words, the case may be put in this way, that you cannot claim a patent for a particular use of an existing combination. There are various instances in the books. For instance, take the case of "Kaye *v.* Marshall" in Clark and Finelly, to which I shall refer presently. That was a patent for improvements in machinery for spinning flax. The improvement consisted, according to the construction placed upon the patent by the court, in putting two parts of a machine rather nearer each other than it had been usual to do. They said, you cannot do that; that was a mere alteration in detail. A man having the machine is entitled to arrange the spaces between the parts of it in such a way as he thinks fit. although it was proved that it was a great improvement, and that it did give special advantages which had not been known in the way in which the machine had been previously constructed; or in other words, by diminishing the spaces between two parts of the machine you obtained a particular advantage which made the machine much more useful than it had been previously. It was said that was not the proper subject matter of a patent; there was no novelty in that. What difference is there between that and telling a person he is to reduce the cross section of his carbon, no particular size being given? Then there is another case of "Ralston *v.* Smith," where there had been a previous patent, or at any rate a previous machine for calendering or printing calico or cotton cloth. It was done by what was called a boll rolling on a roller at an unequal speed, and the object was to calender the cloth and to impress the pattern on it at the same time. But people had found that they could not perform the two operations together, because the action of this boll and roller tore the cloth, and therefore they had to calender by one operation, and they had to impress the pattern on it by another operation. A man discovered, and so far as I can see it was a very useful discovery, that with a particular form of boll—a particular pattern impressed upon the boll—you could do both operations without tearing your cloth; and it was proved that by the means which he described you could impress your pattern and calender your cloth by one operation. But the House of Lords said, that is only a particular use of a previously well-known machine. A man having the right to use this boll and roller with a differential speed has a right to use it of all dimensions; he has a right to use it with either one pattern or the other pattern, either with circles or straight lines or transverse sections carved on it; and you cannot take out a patent for a particular use of a well-known machine. There was another case which, I am sure, my learned friend Mr. Aston will remember, a case about gas purifiers, "Patterson *v.* The Gas Light and Coke Company." Gas manufacturers were in the habit of purifying their gas by means of what are called gas purifiers, which consist of large trays, the first being filled with oxide of iron, which takes out particular impurities, and the others with lime for the purpose of taking out the carbonic acid and the sulphur compounds. Your lordship knows that the gas companies are exposed to heavy penalties if their gas is not up to a certain standard of purity. The Gas Light and Coke Company were almost in despair. Mr. Patterson, a gas referee—it was held that it was not his own idea—took out a patent in which he alleged that he had made a discovery, namely, that if you used the first lime purifiers for taking out the carbonic only and used a certain quantity of lime only in it and changed it more frequently than it had been the custom to do in the previous process, and if you confined your subsequent gas purifiers to taking out the sulphur compounds only, you would gain the particular advantage of making your gas purer. It was an undoubted success, whoever had the merit of it, which was, of course, perfectly immaterial. The gas company's people said it was their discovery and Mr. Patterson said it was his. The Court ultimately thought the gas people were right; but that is immaterial. All the judges in the Court of Appeal and in the House of Lords were agreed that you could not have a patent for that, which was undoubtedly a most valuable discovery, because I think I am right in saying that the purity of the gas went up a very considerable percentage after the introduction of this process. It was a most remarkable change. Instead of being exposed to penalties week by week, the gas company manufactured gas which was well within the standard.

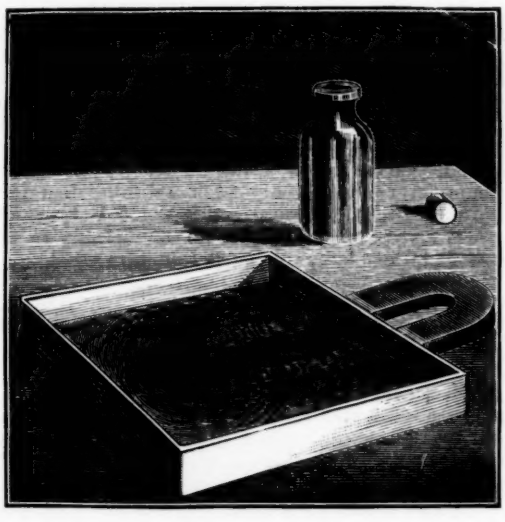
Mr. ASTON: I wish the Solicitor-General had said that at the trial.

(To be continued.)

The Reis Telephone.—By far the most important contribution to the controversy respecting the ability or inability of the Reis instrument to transmit and reproduce articulate speech is that which we publish on page 29 of this week's REVIEW. It ought to produce its effect in America, where the receiver is the main object of legal wrangles, if not in this country.

EXPERIMENTS WITH LYCOPODIUM.

DR. O'CONNOR SLOANE, in the *Scientific American*, describes some very interesting experiments with lycopodium, a very fine powder used largely on the stage for the production of lightning-like flashes. Dr. Sloane states that if the powder be sprinkled on the surface of water it will support comparatively heavy weights, such as steel pens, &c. He further states that the coated surface forms an admirable field for the display of magnetic figures. A tray of paper may be used to contain the water. It must be made water-proof by treatment with shellac or melted paraffine. The paraffine from a candle melted over the surface by the heat of an oven, or by being held in front of a fire, will suffice. A shallow layer of water is placed in it, and the tray rests upon the poles of a powerful magnet. It



is dusted with lycopodium, the excess is blown off, and iron filings dropped on the surface from a considerable height. The filings may need a little assistance by jarring, but they will often, without it, arrange themselves in the magnetic curves, as shown. At the poles, where the attraction is strongest, and where most filings accumulate, the magnet draws them down, depressing the surface quite curiously, but not with power enough, under ordinary conditions, to break through the film. It is a case of two forces being insufficient to overcome the surface strength. Here gravity and magnetism co-operate, but cannot break through.

MONOPOLISTS AND PRIVATE USERS.

THE following letters have been sent to us with a request for their publication. For obvious reasons we withhold the name of the recipient.

"Edison and Swan United Electric Light Co., Ltd.,
"13, Albert Mansions, Victoria Street,
"Westminster, S.W., *June 29th*, 1886.

"Dear Sir,—We find that you are using electric incandescent lamps which are made in infringement of this company's patents which have been recently upheld by the decree of the High Court of Justice under proceedings instituted by the company against other infringers.

"I have to request that you will at once discontinue the use of those lamps, and upon your notifying me of your willingness to do this, I will make arrangements for sending for the lamps at such early date as may be convenient to you. If I hear from you not later than Monday next, 5th July, with the undertaking above referred to, the company will abstain from taking proceedings against you, either for an injunction or for damages; a course which the directors have authorised me to take, in the belief that you were not aware that by the use of the lamps in question you were infringing the company's rights.

"I am, dear sir, yours faithfully,
"(Signed) S. FLOOD PAGE, *Secretary*."

"11, Queen Victoria Street,
"London, E.C., *July, 3rd*, 1886.

"Dear Sir,—With regard to the letter received from you we think you should write a letter to the Edison and Swan Electric Company something to the following effect:—

"'With regard to the lamps you complain of Messrs. Woodhouse and Rawson inform us that they are advised that the lamps do not infringe any exclusive right to which you are entitled and that they are advised that the judgment, from which they are now appealing, cannot be upheld. We therefore beg to refer you to Messrs. Woodhouse and Rawson.'

"We are, dear sir, yours faithfully,
"(Signed) WOODHOUSE AND RAWSON.
"(*Per* A. S.)"

The above letters, received after our remarks in the leading columns of this issue were written, relate to the same matter dealt with therein. To what we have already said we desire to add a few ideas which have since occurred to us. Legally right it possibly is for the Edison Company to proceed against the users of lamps they consider infringements of their own, but it is not in consonance with our views of moral justice to let a firm go on manufacturing lamps and installing them broadcast over the country for four years or more before bringing action, and then suddenly to swoop down upon the innocent purchasers. That such a thing is possible under the existing patent laws is a positive disgrace. If the same practice is to prevail in other branches of trade, what difficulties will beset the purchaser of the most ordinary articles of merchandise! He will be constantly troubled with a feeling of insecurity, and under such circumstances will buy as little as possible, with the result that trade all round will suffer. It seems to us that in two regards the patent law as at present existing requires amendment. In the first place, a patentee or the owner of a patent should be allowed a reasonable period after the commencement of the manufacture of the alleged infringing article within which to bring his action; if in that time he does not move against the infringer he should be held to have no cause of complaint thereafter. Secondly, *bona fide* purchasers of an article which has not been held to be an infringement should never be allowed to suffer inconvenience or pecuniary loss in consequence of any action taken subsequently to their purchase. We are under the impression that purchasers of Sterne gas engines previous to the result of the recent trial of "Otto *v.* Sterne," were allowed to remain in undisturbed possession, notwithstanding that the Sterne engine was held to be an infringement of the Otto. This is as it should be, and the Edison Company errs in so far as it departs from this wise precedent. But instead of cultivating contentment with present success and the prospects of an increased volume of business which that success shadows forth, it has embarked upon a policy of aggrandisement which it will possibly find when too late is calculated to injure itself as much as its rivals. The directors should esteem themselves fortunate in having secured the verdict of the Court in their recent action against Messrs. Woodhouse and Rawson, and they must not count too certainly upon the upholding of Mr. Justice Butt's decision if the case proceeds, as it probably will, to the Court of Appeal. Judges, we know, are showing an increasing tendency to favour the owners of patents and to stretch to the very utmost the capabilities of language in order to make a patentee appear to say what it is palpable to an unbiased person he

did not mean. But public opinion is manifesting signs of impatience at this straining of meanings to suit the views of those who are in possession of the field, and judges are no less mortal, we imagine, than other men, and, notwithstanding their avowed indifference, are no doubt equally sensitive to the expression of that public opinion.

REVIEW.

Electric Transmission of Energy. By GISBERT KAPP, A.M.I.C.E. London: Whittaker & Co.

(SECOND NOTICE.)

Mr. Kapp's book abounds with ingenious passages; it contains a vast amount of original matter, and it bears the signs of much patient thought assisted by practical experience. In chapter III. the author explains the different conditions which he observed in the working of dynamos and motors, and he shows clearly that motors have a theory of their own apart from that of dynamos. We heartily concur with Mr. Kapp's views in this matter, and we trust that in future editions, which, without doubt, will follow in rapid succession, the reactions in motors as different from those in dynamos will be considered at a still greater length. We should have been glad to have seen diagrams representing, graphically, the lines of force as they are supposed to pass between the field poles and the armature cores of dynamos and of motors; with dynamos, it appears as if poles of the same sign were approaching each other, and receding from those of opposite sign. The consequent magnetic repulsion has to be overcome by mechanical energy, the poles of the field magnets are somewhat weakened by induction through the similar poles of the armature, which are always nearer than the dissimilar poles, owing to the lead of the collecting brushes, it is therefore necessary to employ comparatively heavy field magnets in dynamos. With motors the conditions are reversed; mechanical energy is obtained principally by the attraction between the poles of the armature and those of the field magnets which are of opposite sign, and nearer to each other than the repelling poles; therefore the magnetic induction between two sets tends to strengthen both, and it is not necessary to employ field magnets quite so heavy as is the case with dynamos.

Mr. Kapp denounces the Paccinotti armature core on account of its liability to heating, and he assumes that cores with projections are in favour with motor makers, because it is thought that these projections increase the magnetic attraction which determines the force of the motor. There is not the least doubt that the Paccinotti teeth do increase the *statical* effort in a very large degree, and it is mostly in motors which have to give a great initial effect that such armatures are employed. With a careful design and perfect ventilation there should be no excessive heating, and the other advantages offered by projections, such as holding and protecting the coils are sufficient to justify the adoption of this form of core for motors.

Chapter IV. gives us a classification of types of magnets and armatures, it contains Kapp's theory of the "magnetic circuit" and "magnetic resistance." We cannot speak too highly of this theory, which, we believe, has already been of great service to dynamo manufacturers. The formulæ of Jacobi, Müller, Du Moncel and others, expressing the relation between magnetising power and magnetic moments, when applied to dynamo designing, have invariably proved impracticable. Designers had to be guided by experience; the quantity and quality of iron and copper was generally determined by experiment.

Each maker found out for himself a type or form of field magnet and armature, and so long as the required output was obtained from a given machine no one cared much as to the quantity of iron or copper used to yield that output. Mr. Kapp's formulæ enables us to obtain, without costly experiments, the approximate dimensions and speed of a dynamo, they also assist us in comparing machines of the same or of different types. By means of these formulæ and the graphic representations (characteristic curves) in this and the following chapter, we can construct a dynamo or motor and analyse it, and thus learn not only how to design a machine to suit any requirement, but we can also find out in what respects improvements may be effected.

On page 130 we find an algebraic expression which is very ingenious, and on the page following there is a graphic representation of the same law, the object of which is to determine the speed at which a motor should run to give its best efficiency, and we have merely to know the current absorbed by a shunt machine when running empty and its resistance. Mr. Kapp proves the correctness of this law by a practical example, and he adds, basing his remarks upon the figures quoted, that a shunt-wound motor is fairly self-regulating, and that the variation of speed between a full load and no load was only 15 per cent.; and further on the author observes that the extreme variation in speed would be something under 9 per cent. if the motor is worked with its safe current of 45 ampères. Mr. Kapp makes no reference to the experiments of Mr. Mordey, the results of which we published in the ELECTRICAL REVIEW on page 27, Vol. XVII. Therein Mr. Mordey pointed out, and no one seems to have mentioned the fact publicly before him, that a pure shunt-wound motor was almost perfectly self-regulating, the experiments showed conclusively that this particular motor when supplied with a constant E.M.F. gave a variation of speed amounting to only 1·3 per cent. with a wide range of load.

There is every probability that Mr. Kapp has known this fact long before he published his admirable book, and there is also the probability that he has verified his knowledge experimentally before Mr. Mordey concluded his researches, nevertheless, the latter gentleman's views might have been recorded in a book which in a vast number of instances does full justice to authors of statements belonging to this subject.

The classification of systems of transmission given in Chapter VI. is a most reasonable one, and the author enumerates the difficulties which will be met with in cases of transmission of energy where a number of motors are to be supplied from one source. There are no practical examples of this kind in existence, at least we do not know of one in which many electric motors are employed and run from one circuit and at a constant speed. In the case of electric railways, of which we have a goodly number working successfully, it does not matter if the motor which is furthest from the source of supply runs a little slower than the one nearer to the generator; the regulation, moreover, is effected in a rough and ready way by the driver of the car or train by means of resistances or otherwise; indeed, tramcars must be supplied with means for varying the speed and power—but in the matter of regulation of constant speed with varying loads, constant E.M.F. or constant current we have still much to learn.

Curing Corns by Electricity.—A medical man writes to an American contemporary as follows:—"Two weeks ago, after a long trial and little success until the time stated, I found a way to remove warts and corns, and without pain, by using an induction apparatus of my own of peculiar form and shape. The electrodes are of the usual kind. One is an ordinary handle, but the other is a long, sharp needle with a little hole pierced near the extreme point. This needle is first dipped in a solution of soda and iodine, then pushed under the wart as near the flesh as possible, and the current turned on. Three applications of this kind will entirely remove the wart, which will drop out and leave but a small scar." Hope on, ye afflicted ones; a deliverer is at hand!

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

[*All rights reserved.*]

(*Concluded from page* 18.)

"BALL-Kapp-Fein-Maxim-Weston-Thomson-Houston-Bright-Brockie-Ayrton-Perry-Joel-Forbes-Wilde-Elphinstone-Vincent-Cabella-Schuyler-De Meritens-Deprez-Rapieff-FitzGerald-Heinrichs-Hochhausen-Jurgensen——"

"Stay," I cried; "you overpower me! I cannot follow you."

But the dynamo continued, and I started to my feet. Its utterance was becoming more rapid and strangely guttural, and I could with difficulty distinguish its words; but they were evidently names of notable inventors which it had taken unto itself. I strained my sense of hearing to the utmost, and strove to retain in my memory the words I indistinctly caught. But the effort was vain, and I pressed my palms to my throbbing temples to relieve the pressure I was now conscious had been put upon them from within. The jingle of harsh-sounding names was still ringing in my ears, but it gradually became fainter and more faint, until at length it died away into a mere buzzing murmur.

A sense of oppression came upon me, and I remained for a few moments quite still with my hands to my brows. At length I looked up once more, and lo! a complete transformation had been effected in the short space since I had arisen. The dynamo machine no longer possessed the attributes of a human being; it had resumed its former shape, and was now in place with its fellows, running at a great rate and betraying no consciousness of my presence. In my first startled moments I adjured the machine to explain to me the meaning of the vision I had seen and the revelations made to me. But it heeded me not, continuing the even tenour of its way without even a sign that it heard my appeal.

The sensations of bodily oppression increased as my mind grew calmer, and I presently became aware that I was suffering from intense fatigue, from hunger, and from the pains one usually experiences after reclining for a lengthened period upon a hard substance. I now observed, too, for the first time, that night had fallen. The arc and incandescent lamps diffused a bright light around me, but I could see by the depth of the shadows in remote corners and by the blackness without that the hour was late. I tore myself away, for I would fain have remained in that place yet longer. To my dismay I found the adjoining courts silent and deserted. As I proceeded further, however, I perceived that there were still a few stragglers wending their way in a leisurely manner towards the principal point of entrance and exit. This reassured me, for I had begun to fear that I was alone in the vast place, that I had been overlooked and forgotten and the Exhibition closed and left to take care of itself—and the rats. Once outside, I soon procured some refreshment and hurried to my home.

I did not quickly recover from the effects of my long fast and the fatigue I had experienced. A respite from my ordinary labours afforded me time and opportunity to meditate upon and verify the facts which had been communicated to me in so surprising a fashion. Many an hour did I spend in public libraries, and in private libraries too, before I satisfied myself that every detail was correct. So much was new to me, that I hesitated to make known what I had heard. But the result of my researches and enquiries was to dismiss from my mind every shadow of doubt and to clearly substantiate every portion of the dynamo's narration. That being so, I resolved to do as the dynamo desired and publish its history to the world. Now I have completed my task, perhaps not in such a manner as to do full justice to the subject, yet have my best efforts been bestowed upon the work.

Not only, however, did I assure myself of the correctness of the details of the dynamo's story; I availed myself also of the opportunity to store my mind with yet further information upon many subjects of prime interest to me. Rummaging among ancient volumes I now and then happened upon a curious suggestion of more than one modern machine, whose authorship is attributed to one or another whose name was not that upon the book I read. Verily those were pleasant hours! A whole ocean of wisdom into which to dip at will, and none to say me nay. I made abundant use of many books which I then saw for the first time; some, indeed, there were of which I had never even heard before—and these not the least interesting or important. What a vast amount of knowledge is locked away in books that are rarely opened! If one only commenced the search, would he not discover the germs of innumerable theories now prevalent, social and scientific, in the most unexpected quarters? Old time forms of mechanical contrivances now familiar to everyone, perhaps in the crudest imaginable shape, yet sufficiently like the modern development to show their close connection?

The thought has often occurred to me, Did the man who first conceived the notion which, followed out, bit by bit, has led to the construction of some of the beautiful machines we may now see in our mills and factories and workshops—did he dream of the perfection to which his first rude instrument would be carried, and would he recognise the old familiar principle in the present complicated forms? Possibly he would; for inventors are sanguine men and look a long way ahead. Though they cannot immediately construct the darling of their brain, they can imagine, perhaps, the perfected form which others will impart to it when they have departed from this sphere of strife and contention—which others will be enabled to impart by reason of the knowledge they will gain from experience of its working. No invention comes from the brain of its originator in a state of Minerva-like perfection, but reaches its ulterior forms by gradual stages of evolution. One observer notes one point in which a seemingly slight alteration will yield an improved effect; others make additions from time to time which in the sum vastly raise the importance and utility of the contrivance until it has progressed almost beyond recognition. The question in this connection which has not yet received a satisfactory answer is, How far are these mere improvers entitled to credit and to emolument? Undoubtedly many a man has made a large fortune and a world-wide reputation by simply working systematically upon the half-forgotten ideas of other men, who from one reason and another have fallen just short of practical success. These latter have possessed the real genius of invention which is supposed to be rewarded; but others coming after them secure the substantial benefits by reason perhaps of some slight modification. No one will begrudge to the man who converts an inoperative machine into one which has a wide sphere of usefulness a reasonable amount of remuneration. But what is objectionable is that he should have the sole credit of the original invention, and that others should be debarred from even beginning where he begun, and working in the same direction.

My theme, however, is electricity, and turning from these reflections on the past to speculation as to what the future holds in store, the mind loses itself in the contemplation of glorious possibilities. There is a time fast approaching which will be denominated "the electric age." Of that I have no doubt. Events may seem to delay the onward march of this mysterious agency, but it will overcome all and reach its grand destiny in spite of opposition. The day will come when the dynamo machine, now I hope not quite so little understood as formerly, will be as familiar to the public mind and eye as is now the steam engine. I may be told that my expectations are purely visionary; but how often has the so-called dreamer of one age been regarded as an inspired prophet in the next! I lay no claim, however, to inspiration. Hard, matter-of-fact, practical reality is here as encouraging as the most

ardent enthusiast could wish. Speaking with a more or less intimate knowledge of the nature of the electric force and of its varied applications, my convictions are firm that as yet we have but touched the fringe of what will in time unfold itself. We are already acquainted with the use of the electric current for lighting purposes; but even in this direction huge advances have yet to be made, and the prediction is not too sanguine that within the next decade we shall see this most perfect form of illumination giving light and beauty and atmospheric purity to numberless households. This will indeed be something gained from more than a purely æsthetic point of view. But this is only a small department of its future utility. The transmission of power shall yet be satisfactorily accomplished, and whoever wishes shall have the power to substitute electric agency for manual exertion in the ordinary labour of the workshop and the household. Will not the mechanic who works in a small way bless the day when he will be able by the simple act of turning a tap to set his lathe in motion? and in like manner will not the economical housewife be grateful for the ability to sit at her sewing machine without the cruel necessity of laboriously actuating it herself? Then, in that golden age of electricity, horses will no longer perform the drudgery of our street traffic, but will, perhaps, be allotted less ignoble occupation. Tramcars with electro-motors are even now in operation here and there; and what can be applied to tramcars can equally well be utilised for omnibuses and carriages. It is not for me in this place to indicate the details of these projects; but no hesitation arises in my mind as I write that these changes are not only possible but will inevitably take place. Quite as attractive a sphere for the application of the wondrous force is its use upon the water. Pleasing indeed is the sensation of gliding silently and swiftly over the waves without muscular effort, and without the drawbacks usually attendant upon steam propulsion.

There are a thousand and one other uses to which the versatile current may be applied, and many of these will possibly occur to the mind of the reader. I may have something to say regarding some of them on a future occasion. For the present I retire with the earnest hope that I have been instrumental in elucidating what was previously a little obscure in reference to one of the most wonderful of modern inventions.

NOTES.

Electric Railways in America.—Arrangements are being made for the opening of electric railways at Scranton, Pa., Winthrop, Mass., St. Louis, Mo., and Kansas City.

Electric Lighting at Brighton. — At last week's meeting of the Brighton Town Council, it was reported that at a meeting of the Electric Lighting and Gas Committee on June 21st, a letter from Mr. Arthur Wright, managing director of the Brighton Electric Light Company, Limited, stating that the company is now in a position to light the sea front by electricity was again submitted. The committee also read another letter from Mr. Wright giving further details, and it was resolved to have an interview with him at the next meeting. A letter from Mr. Sayer, stating that the Sussex Electric Light Company, Limited, would be willing to light by electricity the King's Road, between the western boundary and the Aquarium, and requesting an interview with the committee on the subject was again submitted, together with a letter from the same gentleman, giving further details and enclosing a sealed tender. It was decided to return the latter to Mr. Sayer with an intimation that the committee would grant him an interview at the next meeting, providing he in the meantime sent them a letter stating the price at which the company would be willing to light the front of the town by electricity. Without discussion the council unanimously passed the report of the committee.

Domestic Electric Lighting.—The Electrical Power Storage Company has just completed and successfully started an installation of the electric light at the residence of Mr. J. Goddard, of Leicester. A 3½ H.P. gas engine drives a 3 unit dynamo, the total number of lamps fixed being 85. The above is one of the finest houses in Leicester, and it will be remembered that the plans of the design occupy a prominent position among the pictures in the Academy of this year.

Electric Lighting Licenses.—A Parliamentary return has been issued showing the applications to, and proceedings of the Board of Trade under the Electric Lighting Act, 1882. Applications for provisional orders were received by the Board of Trade on or before the 21st of December from the Chelsea Electricity Supply Company, Limited, and the West London Electric Lighting Company, Limited. The first of these orders was granted by the Board of Trade, and a Bill to confirm it was introduced into the House of Commons on the 11th June, and will be proceeded with in the next session. In the second order the undertakers, besides the extension of area scheduled, sought power to extend for a period of one year the time within which the compulsory works were to be completed. This order was not proceeded with. Since the date of the last report a further extension of the time within which the deposit of capital should be made in the case of the Fulham District Electric Lighting Order, 1884, had been approved, but the period so extended expired on the 15th instant. Since the date of the last report the Board of Trade had received an application for a license from the Dundalk Town Commissioners. This license had been settled by the Board of Trade. The Board of Trade had also granted two licenses, referred to in the last report, namely, one to the Dalton-in-Furness Local Board in respect of the district of the Board, and the other to Mr. J. E. Veale, in respect of the district of the St. Austell Local Board. After careful consideration, the Board of Trade had decided to insert in licenses granted to local authorities, provisions empowering the promoters, with the consent of the Board of Trade, to transfer all or any part of the powers, duties, and liabilities conferred or imposed upon them by the license as to the whole or any part of the area comprised therein, to any other body or person, and provisions to this effect had been inserted in the Dundalk and the Dalton-in-Furness licenses. In 1884 a license was granted to the South-Eastern (Brush) Electric Light and Power Company, Limited, to light a specified area in the borough of Colchester. In August, 1885, the company went into voluntary liquidation, but the Board of Trade had agreed to the transfer of the undertaking to the Colchester Electric Light and Power Company, Limited.

American Telephone Patents.—Mr. W. Van Benthuysen is still hopeful and enthusiastic. He recently told a New Orleans reporter that while the telephone decision there in favour of Bell (as published in the REVIEW of June 25th) was a surprise to him, he was not dismayed. "I realise the Herculean task of a contest with two gigantic monopolies wielding an influence of $150,000,000. I have learned that success is not attained by every move. We have had our successes in rapid succession, and it should not be forgotten that a reverse now and then is part of the inherent nature of war."

French Telephones.—On the 30th June the committee on the budget met to discuss a scheme relating to the organisation of the telephone system, and submitted to the committee by the Minister of Posts and Telegraphs with the view of deciding whether it should be officially presented to the Chamber of Deputies.

The scheme has for its object the creation of a society, which should buy, on account of the Government, the concessions temporarily granted to the "Société Générale des Téléphones," and carry on the work of the latter as well as the work over the system already established by the Government. The society is to have a concession to work the telephone lines for 35 years without any guarantee of interest. After an interest of 6 per cent. has been paid to the shareholders, the Government is to receive 15 per cent. of the profits. The Government has the right of buying the concession back at any time after the first ten years. At the expiration of the 35 years the Government becomes the owner of the telephone system. The society binds itself to establish telephones wherever they may be required.

West African Cables.—The India Rubber, Gutta Percha, and Telegraph Works Company handed over, on July the 1st, to the African Direct Telegraph Company the cables laid by the first-named company between Sao Vicente and Sao Thiago, and between Sao Thiago and Bathurst. The latter place is now open to the public for messages directed *viâ* Sao Vicente. As previously announced, the Silvertown Company has completed for the West African Telegraph Company the cables between Senegal and Bathurst, and between Bathurst and Bolamo, and news has been received that the Silvertown Company's ships the *Dacia* and the *Buccaneer* have laid the section between Konakri and Sierra Leone for the West African Telegraph Company. As the Telegraph Construction and Maintenance Company has two of its cable ships on the coast, news may shortly be expected that they have completed for the African Direct Company the cable between Bathurst and Sierra Leone. When this section is laid Sierra Leone will be in duplicate communication with Europe, and telegrams can be sent either *viâ* Cadiz or *viâ* St. Vincent. The rate agreed upon between the West African Telegraph Company and the African Direct Telegraph Company for messages to Sierra Leone is 6s. 9d. per word. The *Dacia* is now on her way home, and the *Buccaneer* has proceeded to Grand Bassano, Accra, and Porto Novo to lay the shore ends at these places for the West African Telegraph Company's cables. The *Silvertown* left the river on Saturday with the deep-sea cable for the above-mentioned sections, and with the cable necessary to connect up Porto Novo, Sao Thome, Principe, Gaboon, and Sao Paulo de Loanda.

French Cables.—The Minister of Posts and Telegraphs submitted on the 30th June to the Chamber of Deputies, a scheme for uniting various French colonies by a system of submarine cables.

Telegraphic Reform.—On Tuesday the Congress of the Chambers of Commerce of the British Empire held its first meeting in the Conference Hall of the Colonial and Indian Exhibition. Delegates were invited from 97 Chambers of Commerce and commercial associations, Australasia, Canada, China, India, Indo-China, South Africa, South America, and the West Indies being represented. About 150 gentlemen were present. The chair was taken by Mr. H. J. Tritton, the president of the London Chamber of Commerce. During the sitting Sir James Anderson read a paper on "Telegraph Reform." He said, with reference to the reduction of rates, that if 4 per cent. dividend were guaranteed by the states and colonies most interested in the existing system of submarine telegraphy, it would be possible to adjust tariffs so as to reduce those which were too high, and raise those which were too low. This reduction would give a substantial impulse to the development of telegraphy, and the enormous increase of traffic which would result would in a few years provide a surplus for extensions which could not now be carried out without State or colonial subsidies. As to telegraph reform, he would say that the present abuse of the code system was unfair, if not illegal, and would some day have an abrupt ending. In respect to the neutralisation of cables, it would be evident that if a number of Governments undertook to guarantee interest upon submarine cable property for the sake of controlling the tariffs, it would not be permissible for any one nation to damage or destroy the cables. The greatest deterrent, however, to the destruction of cables in time of war would be the knowledge that there were so many routes by which a message could be sent that the breaking of a cable would not affect the result of even a single battle. Strategical cables could be laid when required; but until then the labour would involve waste of money, while the position of the cables would be known, and so much of their value lost. In laying submarine cables care should be taken to lay them in the track followed by the mercantile marine of the world; and long cables of several thousand miles should be avoided as far as possible, as they could be as easily cut as shorter cables, and required much time and expense to repair. A resolution urging upon Her Majesty's Government the reduction of the Anglo-Indian and colonial postal and telegraph charges, and the neutralisation of cables, was then read by the chairman. The Marquis of Tweeddale, Mr. Macmillan (Sydney), Mr. Bethell (Bombay), and Sir William Adamson (Singapore), spoke on the subject.

Major P. B. Walker, of the Telegraphic Department of New South Wales, resumed the adjourned discussion on Wednesday. He said Sir James Anderson was probably right in thinking reduction of rates would lead to neutralising cables and extending the system, but he did not see how it could affect Government supervision, which must be dealt with on its merits. The companies must look after their own interests. The Colonists were all in favour of reducing rates, and the companies ought to carry out reductions without Government guarantee, relying on the commercial increase of messages. The increase had been for some time past at the rate of 40 per cent., while the increase of the last three years had been so steady and sure as to give the best promise to the companies of the result of reduction. The use of codes could not be abolished, and would be a retrograde step that would disorganise commerce. Sir James Anderson spoke in reply, saying he had only shown that there were methods by which, if Governments combined, cheap telegraphy could be at once introduced of 2s. to India and 4s. a word beyond India. Such a reduction by the companies would mean no dividends to the shareholders for three or four years, and as they were commercial concerns they could not suggest such a course, while to Governments it would only mean risking a million for that length of time with no ultimate loss at all. He had never suggested abolishing the use of codes; indeed, he had advocated for ten years a fair code, and only objected to the outrageous combinations which were offered as words. The resolution was unanimously adopted.

Time Ball for Bradford.—At the monthly meeting of the Bradford Chamber of Commerce held last week it was resolved to request the Post Office authorities to affix a time ball to the new Post Office now in course of erection, for the convenience of the public. None of the Bradford jewellers have hitherto been enterprising enough to rent a time current from the Post Office, and the town is therefore badly off in that respect, but we fear the department will hardly make a free gift to one town of that which forms a source of revenue in others.

Interfering with Telegraph Messengers.—At the Bradford Quarter Sessions last week a betting man, named Emanuel Eastwood, was sentenced to three months' hard labour for having attempted to detain a telegraph messenger who was on his way to certain news rooms with the result of races. Eastwood received sporting messages himself, and the prosecution contended that the prisoner wanted to delay the news room messages in order to give him time to back horses which he knew to have already won races.

Students' Conversazione at the Technical College, Finsbury.—The annual conversazione of the students of the City and Guilds of London Technical College, Finsbury, took place on Friday last, July 2nd; the provision made for the entertainment of the visitors being well calculated to enable them to spend a pleasant evening. On view in the class rooms were exhibitions of the telephone, phonograph, electrical apparatus, manufacture of incandescent lamps, engine and dynamos at work for lighting the building, lathes, chemical apparatus, optical instruments, and a large number of samples relating to the various chemical manufactures, with special reference to alkali, soap, brewing, tanning, &c. There was also in one room an interesting collection of art exhibits, the work of the students. During the evening a lecture was delivered by Prof. Silvanus Thompson on "Waves of Light," and another by Mr. John Castell Evans on "Explosives," both rendered very interesting by a large number of illustrations and experiments. At the same time in another room a concert was given by the College Choir, with a little foreign assistance, kindly given for the occasion. Altogether the evening seemed to be much enjoyed by the large company who accepted invitations.

Fire at Electric Wire Works.—We are requested to state that the recent fire which occurred at the works of the United Electric Wire Company has in no way interfered with the execution of orders.

Scientific Degrees.—Mr. John T. Riley, teacher of mathematics and telegraphy at the Bradford Technical College, has passed in Branch VI.—electricity treated mathematically—at the recent examination for the degree of Doctor of Science in the University of London. Mr. Riley graduated as Bachelor of Science in 1882, and was then placed first in experimental physics with first-class honours.

Gravier's Experiments on Dynamo Machines.—Some researches and experiments have been made by M. Alphonso Gravier, of Paris, on the distribution of magnetism in the pole pieces and armatures of dynamos, and a dynamo embodying his conclusions has been constructed. As regards the pole-pieces, he arrives at the conclusion that the best effect is obtained by making the distance between the ends of the two pole-pieces equal to the width of the pole-pieces, and an experiment demonstrated that by this method of contracting the pole-pieces a machine, unaltered in every other respect and driven at the same speed, showed an increase of 25 per cent. in the electromotive force developed. The armature is altered in cross-section—that is in breadth and thickness, in a certain ratio compared with the magnet. A machine embodying the results of his experiments has been constructed which weighs in all about 15 cwt., giving at 600 revolutions per minute a current of 530 ampères with an E.M.F. of 129·6 volts—a result which must be considered highly satisfactory, as developing a very large electrical efficiency for the weight of the machine.

Electric Launches on the Thames.—On Saturday last a trial took place of the latest electric launch built by the Electrical Power Storage Company. She is somewhat smaller than most of the previous boats, and is built for up river work, being 19 feet long by 4 feet 2 beam. In order to render the trial more interesting it was arranged that the Duke of Bedford's launch should be run alongside. The speed of the small boat was found to be thoroughly satisfactory, and a most successful run was made with the two boats from Kew Bridge to Teddington Lock and back to Millwall. The Duke and Duchess of Bedford were present.

Self-Induction.—We shall be interested in seeing the reply of Prof. Hughes to the renewed criticisms of Prof. Weber. We have serious doubts as to the ability of the pure experimentalist to cope with practician and mathematician combined.

The Strange History of a Dynamo.—The series of papers bearing the above title having now come to an end, we are able to inform our readers that "A. Dynamicable" hopes shortly to commence in our columns a series of papers, in which he will endeavour to make intelligible to the student and the non-mathematician many points which now have to them but a vague meaning, and which text books do not by any means make clear.

Judicial Warping of Patents.—Under this heading Prof. Silvanus P. Thompson, of Finsbury Technical College, has written as follows to the *Times*:—"In the columns of your Law Report of to-day there occurs a most extraordinary instance of the evil tendency at present pervading the practice of even our highest courts of warping or straining the language of a patent specification so as to make it read in some forced sense in favour of a patentee who is backed up by wealthy supporters. This evil tendency, which is deliberately fostered by eminent leading counsel and by a few professional experts, who lend themselves to this mode of securing a monopoly for the patentee, is rapidly bringing into discredit the administration of the patent laws. The present instance, which occurred in the Appeal Court in the case of 'United Telephone Company *v.* Bassano,' arose in the following way. The defendants, who are a small provincial firm of telegraph engineers, had constructed a telephone transmitter in a manner which they honestly believed to be different, not only in design, principle, and mode of action, but even in the materials employed, from the transmitter invented by Edison, the American, whose patent is held by the plaintiff company. There had been some question whether the 'tension-regulator' or mechanism of the defendants' instruments was or was not substantially the same as that described in the Edison specification. Lord Justice Cotton, in giving judgment on this point, made the following statement:—'Edison had mentioned several sorts of tension-regulators, but in that which had been ultimately preferred there were fixed blocks and suspended pencils of carbon which acted by varying the tension according to the distance between the carbon points.' That is a very clear statement of what the learned judge considered the defendants to have infringed. But now comes the extraordinary fact that not only is this passage not quoted from the Edison specification, but there is absolutely nothing in the Edison specification even to support it. 'Fixed blocks and suspended pencils of carbon,' 'distance between the carbon points,' are not suggested and never were suggested by Edison. The words 'fixed blocks' and 'suspended pencils' are never mentioned by Edison. Nay, even the substance 'carbon' is never once named by Edison. The nearest approach to all this in the Edison document is tufts of silk fibre covered with plumbago, or with volatilised metals, and lampblack contained within a case. That a High Court of Justice can be so influenced by eminent advocates as to be able to warp and strain tufts of metallised silk and cases full of lampblack into 'fixed blocks and suspended pencils of carbon,' and then to add that 'it was not the duty of the court to point out the exact particular of the construction to which the infringement was due,' is one of those things which would be incredible if it had not actually occurred yesterday. But can any one explain how or why it is that not only in suits about telephones, but in suits about gas engines and electric lights, the same process of judicial warping of patents has gone on?"

In reply to Prof. Thompson's letter, Mr. John Imray, the well-known patent agent, wrote:—"Under the heading "Judicial warping of Patents" Prof. Silvanus P. Thompson, in a letter published in your issue of this date, alleges that Judges and Justices of Appeal are misled by counsel and expert witnesses to such an extent that they quite misunderstand patent specifications, and consequently give unjust judgments. The learned professor does not think it necessary to mention that he has himself condescended to perform the part of an expert witness, but as he has happened to be on

the wrong side, *hinc illæ lachrymæ*. In the case referred to by Prof. Thompson, that of Edison's telephone patent, a new invention of an important and fundamental character had to be dealt with by the Judges. It was not, like most patented inventions, a mere improvement in constructive details or in specific arrangements or combinations; it was an altogether novel departure, which, coupled with Bell's great invention, has led to a system of communication marvellous as it is useful. In such a case Judges who know their duty do not tie down the invention to the precise details given by the inventor; they look for the principle on which the invention is based, they ascertain what is the spirit and essence, the 'pith and marrow' of the invention, and if they see that, notwithstanding variations of form, material, or arrangements of parts, some rival apparatus has in fact the 'pith and marrow' of the original, they justly pronounce that to be an infringement."

Electric Motor.—A correspondent has forwarded to us an illustrated description of an electric motor which he states is designed to nullify the effects of the "back electromotive force" generated by the motor. No explanation, however, is given of the reason why the inventor should suppose that the apparatus would effect the desired result, and without such explanation we cannot undertake to criticise or express an opinion on the same.

A New Switch Room.—On Tuesday a private view was given of the new central trunk telephone switch room of the United Telephone Company at Oxford Court, Cannon Street, London. The visitors were courteously shown over the whole premises of the company, including offices, workshops, test rooms, switch rooms, &c., explanations being given of the various arrangements and processes. The new switch room will form the central point of a system of exchanges numbering up to the present time about twenty-five, and is intended to be the most perfect arrangement of the kind in existence. It will be the means of very much improving the whole working of the large business of the company, and of overcoming many of the difficulties which have occasioned complaint from subscribers in the past. It was stated that the subscribers now number about 5,000, the charge per annum being £20; each subscriber of this amount being entitled to have his private house connected up for an additional yearly payment of £12. An interesting museum is in course of formation by the company, consisting of the early forms of telephones out of which the instruments at present in use have been evolved, and of samples of the telephones made by those against whom the company has either brought actions for infringements, or compelled in other ways to cease manufacture. One of these was an ingenious instrument enclosed in a cigar box, and made from the instructions of the advertiser of "How to make a telephone for eighteen pence."

A New Application of Electrical Power.—We have before had occasion to place on record the useful work done by means of electricity at Hatfield, both at the Marquis of Salisbury's house itself, and on the estate. In addition to the various operations of lighting, pumping, pile-driving, weed-cutting in the river, and others, another application of the power has just been perfected by Mr. Shillito, the resident electrician of the estate; one which, so far as our experience goes, is quite novel. Ensilage is being stored on a large scale at one of the farms for the use of stock, where for this purpose some of the old farm buildings have been converted into silos. This year it has been decided to chaff the green food before placing in the silo, and this arrangement has necessitated the placing of the chaff-cutter used in cutting up the rough grass some twenty feet above the ground. The electrical power is used not only for driving the cutting machine, but also for elevating the grass to the level of the cutter. Some four tons of rough grass are raised and cut per hour by this means. The generator, a 16-light "Brush" machine, driven by a water wheel, is situated a mile and a half distant on the banks of the river Lea; the electrical power being transmitted to a dynamo of Siemens Brothers D 2 type, specially wound to work as a motor with the "Brush" machine. The same source of power is also brought into use in working the elevators at the various hayricks on the estate.

Incandescent Lamp Patents.—We hear it announced that there will shortly be introduced into the market an incandescent lamp which is without the claims of Edison's patent, inasmuch as the filament is not of carbon. It is also said that the company about to work the invention will carry on business at the Cadby Hall Works, now occupied by Messrs. Woodhouse and Rawson. We shall hail the advent of a new lamp with great satisfaction.

Operating an Organ by Electricity. — The new organ now being constructed in Canterbury Cathedral by Messrs. Willis, will be, when completed, in every way worthy of the grand old edifice of which it is to form a most important part. The entire instrument will be operated by electricity, the supply being derived from a battery which is being placed in the old Singing School. Some idea of the wondrous properties of the new instrument may be gathered from the fact that the length of the cables conducting the electric currents average 120 feet from the console (or keyboard) to the pneumatic levers operating the valves of the sound boards. The organist will occupy a raised position in the second arch of the south aisle, just over the spot where the old instrument was played, his manipulation of the keys being flashed by means of the electricity through the 120 feet of cable to the action of the instrument in the triforium above. The organ will be blown by four men in the old Singing School. The whole of the patents employed in the pneumatic and electric action are the inventions of Messrs. Willis, who are affording good evidence of their intention to thoroughly sustain their world-wide reputation in the work upon which they are now engaged.

Forming Metal Sheets by Electro-Deposition.—A new method for forming sheets of metal by electro-deposition has been recently invented, states the *Universal Engineer*, which involves the use of any apparatus which is organised to deposit copper or other metal by electrolysis upon a continuous band cathode, from which it may be removed, when of sufficient thickness, in sheets, after which it is rolled or otherwise treated for the purpose of giving it the desired form and character. A continuous belt of conducting material is employed for the cathode of the electro-deposition plant, which extends over suitable rollers, one or more being driven by steam, and serving to carry the band in a horizontal direction through some of the deposition vats. The positive pole of a battery is connected with a series of strips or plates of the metal to be deposited in each vat. These plates extend in proximity to the cathode band as it is passing through the corresponding vat. The negative pole of the battery is connected with a series of conducting-rollers, against which the cathode presses as it is passing through the vat. The metal is dissolved from the anode plates and taken up by the electrolyte employed, and from that it is deposited upon the cathode. The cathode is passed respectively through the vats, and each time receives an additional deposit until the required thickness is attained.

Utilising Waste Steam.—Messrs. Klein, Schanzlin and Becker, Frankenthal, Rheinpfalz, Germany, are said to have introduced a small steam engine in which no steam is allowed to escape, it being all condensed and used over again. It consists of a vertical cylindrical tubular boiler, the engine attached, with feed pump, a tubular condenser, and an air regulator for the fire. The machine is said to work well and to be readily accessible in all its parts.

The Upward Primary Battery.—We beg to refer a correspondent, "L. G. S.," who does not make known his identity, to Mr. Upward's letter in this our present issue.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Coates, Macdonald and Company (Dealers in electric, photographic, and other scientific apparatus). — The statutory return of this company is made up to the 20th January last. The nominal capital is £15,000 in £5 shares, 308 shares have been taken up, and upon 208 of these £2 10s. per share has been called, the full amount being considered as paid upon the remaining 100 shares. The calls paid amount to £330, leaving £190 unpaid.

Hastings and St. Leonards-on-Sea Electric Light Company, Limited.—The annual return of this company made up to the 22nd ult. was filed on the 29th ult. The nominal capital is £50,000 in £10 shares. The full amount has been called upon 683 shares, the remaining 167 shares (issued to the Hammond Company) being considered as fully paid. The calls paid amount to £6,785, leaving £45 unpaid. As compared with the previous return the paid up capital shows an increase of £6,055.

Edison Indian and Colonial Electric Company, Limited.—At an extraordinary general meeting of this company, held at 4, Lothbury on the 11th ult., it was resolved, with a view to amalgamation with the Australasian Electric Light, Power and Storage Company, to wind up voluntarily, and Messrs. Samuel Flood Page and J. D. Austen Norris are appointed liquidators at a remuneration of £210, to be divided as they may think fit. One fully paid ordinary share and one fully paid deferred share in the Australasian Company will be issued in respect of each fully paid A share held in the company. The resolutions were confirmed on the 28th ult. and duly registered on the 29th ult.

Telephone Company of Egypt, Limited.—At an extraordinary general meeting of this company held on the 25th May at 14, Austin Friars, amongst other alterations made in the Articles of Association, it was provided that the remuneration of the directors shall not exceed £800 per annum, but the actual amounts to be paid to them shall be settled and determined in each year by the shareholders in general meeting for the ensuing year. The number of directors is not to be less than three nor more than seven. The resolutions were confirmed at a meeting held on the 22nd ult. and were duly filed on the 29th ult.

CITY NOTES, REPORTS, MEETINGS, &c.

United Telephone Company, Limited.

THE sixth ordinary general meeting of this Company was held on Tuesday at the City Terminus Hotel, the Chairman, Mr. James Brand, presiding. Mr. Thomas Blaikie, the Secretary, having read the notice convening the meeting,

The Chairman said: You will have noticed from our report that, so far as our accounts are concerned, we have entirely separated the business of our metropolitan area from the general business of the company. As regards the capital expenditure, we have spent £143,600 in our metropolitan district, and £43,000 on instruments now in use in the metropolitan district and subsidiary companies. This shows an increase of about £26,000 as compared with last year, and has resulted in an increase of gross revenue of nearly £20,000, and an increased net revenue of about £11,000. This net increase would have been much larger, but we thought it right to debit revenue with the whole cost incurred through the snowstorm of January last. I may say that we would have been justified in debiting capital with a good deal of the amount, as while replacing poles and wires that had been damaged, we took the opportunity of making good provision for increasing business by strengthening our poles and running cables which would tend to diminish the multitude of wires. As to the dividend, we propose to put £100,000 to the reserve fund, and we have already placed £2,700 to the same fund arising from exceptional profits. The reserve will now, therefore, be about £97,000, and we have also made a provision in excess of maintenance for the depreciation that is always going on in the metropolitan system. This leaves us a balance of profit sufficient to pay 9s. per share in addition to the 4s. we paid as interim dividend, leaving £2,284 to carry forward. So much for the accounts. As to the working and progress of our business, we have increased our exchanges during the year in the metropolitan district from 19 to 25, and our subscribers have increased from 3,820 to 4,393. The National Telephone has 49, Lancashire and Cheshire 43, Northern District 10, Telephone Company of Ireland 4, Western Counties and South Wales 9, South of England 22, giving a total gross income of nearly £300,000 per annum. In 1885 we passed over the wires 15,565,000 messages, in 1886, 17,730,000. Besides the additional exchanges we have call rooms at Kilburn, Clapham, Balham, Norwood, Coleman Street, Oxford Court, Chancery Lane, Heddon Street, Houses of Parliament; and we are nearly ready for opening stations at the Temple, the Law Courts, Herne Hill, Holloway, and Earl's Court. These do not bring direct profit, but they help to popularise the business, and will form bases for future exchanges. We find people rather slow to avail themselves of the facilities we offer them, habits are so slow to change. The arrangement we made with the General Post Office, whereby subscribers are allowed to speak their telegraphic messages instead of sending them by hand, has been made use of to only a very small extent. Experiments are being made daily by all concerned in long distance telephony. I believe that we are approaching within reach of connection by telephone between London and some of our chief out ports. We ourselves have spoken to Bristol from Westbourne Park, and I understand from Uxbridge to Liverpool. The great difficulty, however, is to get a line of wire clear from the influence of other electrical wires; and this is what we are now striving to do. We are continually told that our prices are too high, and that we should get a great increase to our subscribers and over our system if we lowered our rates. We have lowered our rates wherever we can, and any £20 business subscriber can now be joined up with his private house for £12, but every addition to our large system increases the difficulty and the expense of working the system, and it is much better to try and give a perfect service at a reasonable charge than by reducing the cost to get so many subscribers at a low rate as would render our difficulties greater, and this is the experience of the American and Continental Exchanges. In a small town with a few subscribers to an exchange a lower tariff can be adopted; but when the communication is to thousands instead of hundreds the cost and the complications are immensely increased. And in America, where the number of subscribers is very large indeed, many business firms pay large additional sums for being upon separate express systems. The lowest charge in New York is £30 per annum, and in Paris it is £24. Our system is so valuable in consequence of the great number of subscribers who can communicate with one another. Mr. Vail, the chairman of the Bell Telephone Company of America, says the service is divested of half its value the moment half the people retire to a second system. The value of the thing consists in placing each person in the same system with each other. We are very sorry we have again to write off a large sum for law expenses; and we had hoped that the decisions of previous years would have been sufficient to maintain our patent rights without further litigation; but we are paying the usual penalty of success. So long as money is to be made by it there will be persons ready to convert other people's inventions. We think we have been able to show you a good account, but if we are to go on and prosper every one of our shareholders must put his shoulder to the wheel, and not only bring in more subscribers to our systems, but enable us to put them on as quickly as possible by getting way leaves, because although very often we can get subscribers, it takes us a long time to connect them. We have just completed the renewal of two of our largest exchanges and our central trunk exchange with the most perfect switch-board in existence; and while these alterations have been going on our business has had to be conducted all the same. We believe that in a month's time we shall show our subscribers a very much improved working. We shall then proceed to re-enter our other exchanges in turn on the same system. In the meantime we shall be glad if shareholders and subscribers will visit our exchanges, and they will be able then to estimate the great difficulties we labour under in our arduous endeavours to carry out the telephone system of London. The directors had hoped that the decisions which had been obtained, confirming the validity of the company's patents, would have enabled them to maintain these patent rights without further serious litigation, but we are paying the usual penalties of success. So long as money is to be made by it there will be men ready to convert other people's inventions to their own purposes. Mr. Edison in his patent uses a diaphragm which receives the sound wave from the voice. Messrs. Bassano and Slater used a vibrating mouth-tube and back board, which served the same purpose, and they contended that this was not an infringement, because they used no diaphragm. Mr. Justice North decided last year that it was an infringement, but the defendants, not satisfied with this decision, carried the case to the Court of Appeal, and within the last fortnight that Court unanimously confirmed Mr. Justice North's decision. Unfortunately these gentlemen who infringe are not always in a position to pay the penalty of their misdeeds, and as soon as they are asked to pay the costs they

promptly take advantage of the Bankruptcy Act. In this case the defendants have paid not a farthing in the way of dividend in their bankruptcy, but having succeeded in getting together £100, which they paid into court by way of security, they were able to carry the appeal to a hearing. It is, however, only by vigorously proceeding against infringers, and insisting upon the delivery up of infringing instruments wherever found, that it is possible to prevent the wholesale infringement of the company's patents, and this necessarily involves a considerable expenditure. And we must look upon this—a necessary charge to maintain our own revenue—like the expenses of the coastguard to prevent smuggling. In conclusion, the Chairman moved the adoption of the report and the declaration of the dividend as recommended by the directors.

Mr. J. S. Forbes seconded the resolution.

Mr. Donovan said he had been requested to ask the number of subscribers, because, multiplied by 20, they did not agree with the amount mentioned in the report.

The Chairman: Do you want to know the number of the subscribers to the central systems or of the private wires?

Mr. Donovan: The private wires.

The Chairman: All the private wires are different prices—all sorts of prices varying from £3 to £60.

Mr. Donovan: That will account for the discrepancy.

The Chairman: Yes, I think so. Then there are all the £12 wires which are a good deal taken advantage of for connecting up subscribers with their own houses. Any £20 subscriber can be connected with his own house, if it is within the metropolitan area, for £12 additional.

Mr. William Abbott said it spoke a great deal for the character of the report that the shareholders upon this occasion received the chairman's remarks without making any comment upon them. It was not his intention to make any adverse criticism on the report, because if he were so disposed he could find nothing on which to hang remarks. But he waited for the issue of the report to see if it was the intention of the directors to make any movement with regard to the very large dormant asset which they retained in subsidiary shares. The time had arrived when that very important question should be carefully considered. It was far from him to wish it should be considered by the shareholders in a spirit of hostility to the board, but he wished that it should be considered in the interests of the shareholders, and in the interests of the company. He had addressed a respectful letter to Mr. Brand, the chairman, suggesting that now was the time when this question should be taken into consideration. It was quite impossible that they should keep down their dividend to 13 per cent.; the next dividend, as far as he could see, must be 15 per cent., and it must go up to 20 per cent. This company was only in its infancy. They had only really scratched the surface of telephone enterprise in London alone, and they certainly had gone very little below the surface in the development of telephone enterprise in the provinces. That being the case, he made a suggestion to the chairman. He stated that he saw several advantges in the plan he proposed, one of which was that those £600,000 odd of shares of the nominal value of £6 10s. should be placed in a trust, the directors remaining the trustees, and that against those shares they should issue to each shareholder a bonus certificate to bearer of the nominal value of £6 10s., and of the actual market value of about £4. The reason why he made the suggestion was that, in view of the increased dividend which was certain to come it was unfair that those shareholders who had borne all the trials and anxieties with the directors should not, now that the time had arrived, have taken into consideration such a distribution as he proposed, and which he thought would not only be feasible, but very acceptable to the members. In a letter, which he hoped he might be allowed to circulate, he maintained that the new shareholders who came in as fresh partners had no right to participate in those shares. They came in as partners on the dividend-earning power of the company, and not to share in the accumulations which by the foresight of the board had been created. He said in his letter: "The issue of these 'bonus trust certificates' in such proportion as may be decided upon would not really reduce the value of the original share, as there is every prospect that with the increasing business the dividend will now steadily augment." And now came the most important point: "The permanent augmentation in value of both classes of shares by the creation of a new proprietary, whose interests would be largely identified in the development of the subsidiary companies." The chairman attached in his opening address great value to the point he had mentioned; he referred to the widening out of the proprietary, and to the widening out of the subscribers, which would bring in an increased revenue to the present company. He maintained that the plan he proposed would have that effect—it would largely augment the interest people took in telephone enterprise which was hardly known and understood. In Wales the other day he met a gentleman who hardly believed in the possibility of talking at a short distance; if this were understood the value to the parent company would be largely increased. His other point was: "That the directors being also the trustees, the control of the sub-companies does not pass away from them." That was most important. It would be a very serious matter if those shares of the sub-companies passed into other hands, and if the directors had not the full control of the sub-companies. No doubt Mr. Brand would say that the sub-companies were only in their infancy, and they were parting with a valuable asset which had not been properly developed. He would reply to that, "Perfectly true; but while you are going on hatching these golden eggs surely the shareholders may have them in another form. There can be no objection to their having them in the shape of bonus certificates." Some of those whom he represented—and he represented shareholders holding 2,000 shares—had an idea that they might as well enjoy the fruit which they had sown during their lifetime.

The Chairman said that they had done nothing with regard to legislation. No one had said anything to them, and they had not said anything to anybody. Of course the directors would do their best with regard to legislation. He did not know that he could say any more than that. With regard to the remarks of Mr. Abbott, he did not take exception to anything that gentleman had said. The matter was one that would require very serious consideration on the part of the directors. He wanted Mr. Abbott, in advocating all the things that appeared to him to be so good in their company, not to pile it up too much, as they were surrounded by all sorts of people who might take advantage of it. What he told Mr. Abbott when that gentleman called upon him was that the principle he and his colleagues went upon was to raise the value of their shares by paying good dividends. It was the bounden duty of the directors to think of everything that was to the good of the company, and if Mr. Abbott at any time would like to come and see him, he would tell him if he was getting any nearer to Mr. Abbott's way of thinking.

The motion was then put to the meeting, and carried unanimously.

The election of Mr. E. Dwyer Gray to a seat at the board was confirmed, and Mr. Dillwyn Parish and Mr. W. Cuthbert Quilter, were re-elected directors. The auditors, Messrs. Quilter, Ball and Co., and Messrs. Price, Waterhouse and Co., were reappointed.

A vote of thanks to the chairman and directors then terminated the proceedings.

The West African Telegraph Company, Limited.

THE first ordinary general meeting of this company was held at the offices, 98, Cannon Street, on Friday, the 2nd inst., Sir Frederick J. Goldsmid in the chair.

The Secretary having read the notice calling the meeting,

The Chairman said the statement of accounts submitted was of a *pro formâ* character, to meet the requirements of the company's articles of association, and the items did not appear to require explanation. The prospectus of the company was not issued until the 8th of April last, but a considerable amount of work had been done previous to that date. In order to comply with the conditions of the concessions, it was necessary that the first sections of the cable should be completed within six months. Accordingly by the 5th of December the cables between Senegal, Bolama, Bissao, and Conakry were laid, and in the same month opened to the public. This fact was practically important, because from this particular period the company was entitled to such portions of the Portuguese guarantee as might be applicable to those sections, and also to the French subsidy for Conakry. Since issue of the prospectus much progress had been made in carrying out the work contemplated. The contractors' cable steamers *Dacia* and *Buccaneer* left the Thames on the 22nd May, and information had already been received informing the directors that communication had been established with Bathurst, and a station opened there. They had also pleasure in reporting that the cable between Conakry and Sierra Leone was successfully laid, and communication opened on Wednesday, the 30th ult. Up to that time the directors had every reason to be satisfied with the manner in which the contractors were fulfilling their contract, and it was expected that the company's system will be completed to St. Paul de Loanda by the middle of October, or some two months before the period required by their Portuguese and French concessions. The directors had also to report that since the issue of the prospectus they had entered into a working agreement with the African Direct Telegraph Company, which gave very favourable transit rates to the West African Company, and the permission to land at the English colonies enabled this company to compete with the African Direct Company on equal terms for the traffic of those stations. He concluded by moving the adoption of the accounts to the 31st December, as presented, which was carried unanimously.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of June was 3,376, estimated to produce £2,775, against 3,715 messages, producing £3,032 in the corresponding month of last year. The receipts for the month of March, estimated at £3,300, realised £3,345.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th June are £2,862, as compared with £2,895 in the corresponding period of 1885. The March receipts, estimated at £5,959, realised £6,193.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 2nd were £2,206, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for June, 1886, were £23,800; from January 1st to June 30th, 1886, £124,500; in the corresponding months, 1885, £142,840; and of 1884, £129,520.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of June, 1886, were £1,513 against £1,343 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for June amounted to £45,100, against £41,514 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending July 2nd were £2,889.

NEW PATENTS—1886.

8608. "Electric safety lamps for use in mines." M. SETTLE. Dated July 1.

8616. "Galvanometer." O. F. Jönsson. Dated July 1. (*Complete.*)

8620. "Construction of thermo-electric batteries." G. E. DORMAN. Dated July 1.

8686. "Making mechanical telephones." F. E. MACMAHON. Dated July 2.

8688. "Armatures for electric generators." G. T. TUGWELL. Dated July 2.

8691. "Mechanical telephones and insulators for the same." W. E. LEA. Dated July 2.

8693. "Use of a new electrolyte in secondary cells." W. J. S. BARBER-STARKEY. Dated July 2.

8739. "Electrical signalling apparatus." H. H. LAKE. (Communicated by L. Sellner.) Dated July 3.

8758. "Electric arc lamps." L. HANSON. Dated July 5.

8786. "Dynamo-electrical machines." S. H. LACY. Dated July 5. (*Complete.*)

8788. "Devices for opening and closing electric circuits." H. H. LAKE. (Communicated by R. Snyers.) Dated July 5.

8814. "Telephones." A. J. BOULT. (Communicated by A. M. Phelps.) Dated July 6.

8832. "Saline preparation for use in galvanic batteries; making same." A. SCHANSCHIEFF. Dated July 6.

8842. "Plates without support entirely made of active material for voltaic batteries." E. ANDREOLI. Dated July 6.

8901. "Making incandescent electric lamps." A. BERNSTEIN. Dated July 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

7582. "Improvements in telegraphy." T. J. HANDFORD. (Communicated from abroad by T. A. Edison, of America.) Dated June 22nd. 11d. A line is employed as usual, grounded at its ends, and having the ordinary main battery. Each office (both terminal and way) has a set of Morse instruments, composed of a key, and a relay controlling circuit of a sounder and local battery. With these ordinary Morse instruments telegraphing is carried on by Morse signals in the usual way. At each office is a device working independent of the main battery, and acting to induce in the line impulses of high tension. This device is composed of an induction coil, the secondary circuit of which may be located directly in line. The primary circuit of this coil includes a battery and a back point key. Or in place of this key a back point sounder worked by a key and local battery may be used. The ordinary Morse key is shunted by a condenser, so that the line will be always closed for the induced currents. This condenser also preferably shunts the relay. To receive these induced currents there is provided at each office a diaphragm sounder which is preferably constructed upon the principle of the electro-motograph, a diaphragm being kept under tension by a spring held by friction upon a revolving chalk cylinder. The chalk cylinder is rotated continually by a motor, electric or mechanical, and the circuit is closed through the spring and cylinder. This construction of instrument is a well known telephone receiver, and hence does not require further description here. For the diaphragm sounder a magneto-electric telephone or other form of telephone receiver may be used. The diaphragm sounder at each office is preferably located in circuit with a condenser, and this circuit is preferably a shunt around a resistance located in the line, which resistance is preferably formed by the coils of an electro-magnet. By the manipulation of the back point keys (or the working of the back point sounders) signals are thrown upon the line in the form of momentary and sharply-defined waves, which are responded to only by the diaphragm sounders, the regular Morse relays not acting quick enough to respond to these waves. The regular Morse keys being shunted by condensers, the line is always closed to the high-tension induced currents, and since such condensers have what is equivalent to a low resistance on the instant of closing circuit, it will be seen that a free path is always provided for the momentary impulses of induction. By extending these condenser shunts to include the relays as well as the keys, a desirable result is obtained, in that the counter-electromotive force set up by the relay magnet effectively stops the passage of the induced impulses by way of the key and relay, and makes the condenser circuit practically the only one closed to these impulses. The effect of this action is to make the induction circuit of practically the same resistance whether the regular Morse keys are open or closed. The induced impulses thrown by the induction coil upon the line are produced by a source of energy (the local battery in its primary) independent of the main battery. These impulses are practically the same whether the regular Morse keys are opened or closed. By arranging the operating key so that the down stroke will open the primary circuit and the up stroke will close that circuit, the signal for the down stroke of the key will be louder than for the up stroke, since when the primary circuit is closed it absorbs to a certain extent the induction and the impulse in secondary is weaker than when the primary is opened. The back point sounder, worked by key and local battery, operates the same way. This difference in the down and up strokes of key is an important one, since if the two signals required to mark the interval of time denoting a dot or dash were the same, the receiving operator might be frequently confused by mistaking the last signal of a dot or dash for the first signal of the next succeeding dot or dash, and get what is called in telegrapher's parlance the "back stroke."

11898. "Improvements in and apparatus for electrically indicating or recording at a given point the movements of indicators or the like at a distance or the movements of any regularly-operated device." W. P. THOMPSON. (Communicated from abroad by C. L. Clarke, of New York.) Dated October 6. 11d. The invention consists generally in organising the apparatus in substantially the following manner. The governing instrument, which is one organised to respond to any varying force, or to be operated at regular intervals, or to move constantly under the influence of a constant force, is provided with a circuit-closing device constructed to transmit electrical impulses of a character and with a frequency dependent upon the direction and amplitude of the movements of the controlling instrument. The various parts of the apparatus are so constructed that immediately upon the completion of a circuit by the transmitter, or by the primal circuit-closing device, a shunt circuit will be automatically completed around this device. This shunt circuit remains closed until a separation of the primal contact points has been effected. The shunt circuit is completed through a strong and firm contact-point, thereby ensuring more perfect circuit connections than can be readily obtained by the primal contact when it is operated by delicately-adjusted devices. This also prevents the circuit from being accidentally interrupted before the electro-magnets, which it is designed to operate, have been vitalised, and it at the same time prevents electrical discharges from occurring at the delicate contact-points. The receiving instruments are provided with devices for advancing an indicating arm or device correlatively with the movements of the transmitting device or governing instrument, and these devices are caused to be operated whenever a circuit is completed. When the receiving devices have been operated, it is necessary that the circuit should be again interrupted, and this has usually been accomplished by means of an interrupting device actuated by an electro-magnet inserted in series with the other electro-magnets, but constructed to respond more slowly, and to thus be brought into operation after the other electro-magnets have performed their functions. It sometimes chances, however, that some one or more of the actuating electro-magnets may not operate as quickly as the others, and the interrupting device may respond before some other device has performed its functions. It is very essential for the perfect operation of the telemeter system that all the devices should operate before the final interruption of the circuit occurs. For this reason it is proposed by this invention to place the interrupting device under the control of currents caused to traverse a third circuit, the connections of which can only be completed when all the operating electro-magnets have been vitalised. This third circuit has its connections completed at different points by the movements of the armature-levers of the respective operating electro-magnets and when completed the interrupting electro-magnet is vitalised and the circuit connections of the battery are interrupted.

1886.

4882. "Improvements in rotary dynamometers." D. BANKI. Dated April 7. 6d. The fixed shaft, carrying freely the loose

FIG. 1.

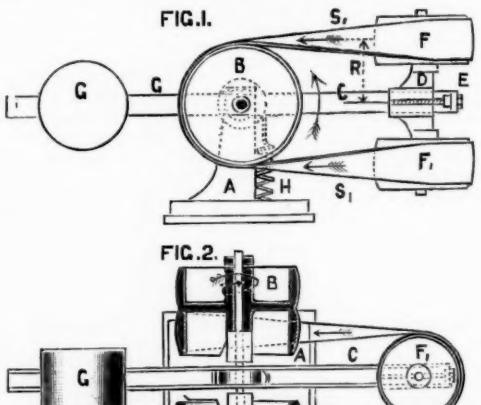
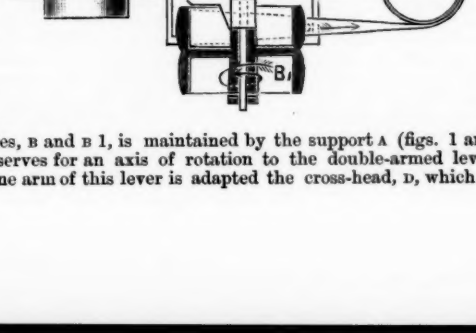


FIG. 2.



pullies, B and B 1, is maintained by the support A (figs. 1 and 2), and serves for an axis of rotation to the double-armed lever, C. To one arm of this lever is adapted the cross-head, D, which may

be adjusted by the screw, E. To the cross-head are fastened the pivots around which revolve the rollers, F F 1. To the opposite arm of this lever is fixed a counter-weight, G, balancing the lever. A spring, H, is secured to the plate of the support and connected with the lever, C, by a steel band. An endless belt passes over the pullies, B, F, B 1 F 1. In working, this belt transmits the movement from one pulley (B 1) to the other (B.) Supposing for instance that the pulley, B 1, is moved by the motor in the direction of the arrow and that the pulley, B, transmits the movement to the working machine the consumption of force of which is to be measured. The upper belts, s 1, s 2, are then in tension and the lower belts, s 1^1, s 2^1, are loose. The difference of the tensions (s 1 + s 2 − (s 1^1 + s 2^1)) acts with the arm of momentum, R, on the turn of the lever arm, C, in a direction opposite to the elasticity of the spring, H. A recording apparatus registers the movements of the spring. In lieu of the transmitting belts, s 1, s 2, s 2^1, s 1^1, a chain or a rope may be used.

CORRESPONDENCE.

Bleaching by Electricity.

In your issue of last week you ask us what we say to certain articles on bleaching by electriciy, published in *The Dyer and Calico Printer*, and signed by Mr. W. Watson. We thank you for calling our attention to the articles, which we have carefully read, and which have afforded us considerable amusement. We beg to say that, so far as Mr. Watson comments upon Mr. Hermité's process, he is entirely at fault. He appears to forget that there is such a thing as a French notation in chemistry, consequently the whole of his comments on this process are without value; and as for the final sweeping assertion, it is merely an expression of opinion, and can, and doubtless has been, taken for what it is worth. We have pointed out the peculiarities of the article to the editor of *The Dyer and Calico Printer*, and have reason to believe that the next issue of this paper will considerably modify their views upon this subject. We must strongly protest against such an exceedingly misleading article being printed and circulated in a technical paper, and, in conclusion, must say that not only do we not agree with Mr. Watson in his final conclusion, but we are perfectly satisfied that Mr. Hermité's electro-chemical system of bleaching is an unqualified success. Hoping that we have not too far trespassed upon your valuable space,

Paterson and Cooper.

London, *July 1st*, 1886.

The Upward Primary Battery.

Allow me to answer several papers and letters relative to Upward's battery, published in your REVIEW.

I invented a chlorine battery, or, more exactly, improved the chlorine battery first discovered by De Fonvielle and Humbert. This battery, described as follows in "Traité de la pile Electrique, par A. Niaudet," was abandoned by the inventors:—"This is a zinc carbon battery with hydrochloric acid. The depolarisation and regeneration of the exciting solution is obtained by means of a current of chlorine. This cell was very powerful and constant."

I tried such a battery without success; the current was not constant, electromotive force on open circuit, 2 volts. I rendered this cell constant by depositing broken carbon around the carbon plate, which may, however, be a lead one, and using a porous diaphragm. Then the electromotive force was 2·1 volts with a current of 9 ampères through a resistance. As a diaphragm I employed firstly a porous pot, then asbestos cloth, and lastly parchment paper, with which a cell 8 × 9 × 5 inches gave more than 36 ampères on a meter. Some of these improvements were patented by me in the middle of last year. I pointed out in my patent the use of common salt, or chloride of zinc, which was employed in the above tests. I am now preparing an additional patent which completely distinguishes my battery from Mr. Upward's.

Now, let us see in what manner the Upward battery is economical and rational. This is not to under-rate the battery but to show there is much to be done in that way.

Mr. Upward does not use liquid around the carbon, but this is always moist; I use very good conducting liquid (common salt); thus the internal resistance of an $11\frac{1}{2} \times 5\frac{1}{2} \times 12\frac{1}{2}$ inches Upward's element is 0·2 ohm, and one of mine, smaller, gives 35 ampères.

By using no liquid, Mr. Upward supposes that chlorine acts not as a depolariser, I cannot admit this; and that zinc combines itself directly with chlorine, which combination is prejudicial to the system.

The following can be given for the chemical action:

I. Around zinc ... $HO + Zn = ZnO + (H)$

Around carbon ... ... $\overset{+}{(Cl)} = HCl$

II. (After working sometime):

Around zinc ... $HCl + Zn = ZnCl + (H)$

Around carbon ... ... $\overset{+}{(Cl)} = HCl$

Admitting, with Mr. Upward, that the zinc is burned only by chlorine, we have

$$HO + Zn + Cl = Zn\,Cl + HO$$

but, as there is an electric current, hydrogen is produced on the carbon and combines itself with chlorine, and the oxygen of the water remains free or burns the zinc. Then you see that for one equivalent of zinc burned there would be two equivalents of chlorine absorbed; this would be onerous. But it is clear that the chemical action is not the above when the battery is at work for some time, then it is only a zinc-carbon-chlorine-chloride of zinc primary battery.

I say that Mr. Upward's cell is not so economical as mine; the internal resistance is about five times greater for equal size; this, combined with the use of accumulators to give light, is a double source of great loss of power. The great resistance can be avoided by using large cells, but then the first cost becomes very considerable, and all the economy of the system disappears.

Mr. Upward's battery is undoubtedly very remarkably well combined, but it wants improvements, and before all, the diminution of internal resistance.

It seems to me I had more success by using and improving the "complete liquid" battery with continuous flow of chlorine.

If I did not abuse your space and time, gentlemen, I should be glad to send you a description of my patents, but this would perhaps be more interesting for Mr. Upward than for your readers, and I am quite at his disposal for every information.

W. Dierman.

University of Ghent, Ghent (Belgium),
July 6th, 1886.

[We should be very pleased if Mr. Dierman would favour us with an illustrated description of his battery, and we feel sure that our readers would be equally interested with ourselves.—EDS. ELEC. REV.]

In reply to Mr. Walker's letter in your issue of June 25th, I think that he will have found that his objections are really answered in your elaborate description of the same issue. Surely it would have been far better for Mr. Walker to have inspected the battery which has now been at work without failure or breakdown for some months, before rushing into print and attempting to criticise it, especially when it is remembered that a very considerable number of eminently scientific and practical men who are really capable of forming a sound opinion on electrical matters have taken the trouble to minutely inspect the whole apparatus for themselves and are unanimous in their approval.

Now to take Mr. Walker's objections in order :—

First, complication of the chlorine generator. The whole labour involved in making the gas simply amounts to this : turning a tap, like an ordinary water tap, which admits the charge of dilute acid to the retort, and when it is required to make fresh gas a similar tap is opened at the bottom of the retort, which allows the waste solution to run away through a closed leader pipe down to the drains ; this tap is then closed and a fresh charge of dilute acid admitted. An earthenware tray with convenient handles placed in the retort holds sufficient peroxide of manganese for two or three weeks' work ; at the end of this time the tray is recharged and replaced. Before removing the lid of the retort for this three-weekly operation, a water tap in connection with it is opened, and by this means every particle of gas or trace of smell is absolutely washed away ; the lid fits into a water lute so that the act of replacing it absolutely seals the retort. The whole operation of making the gas, which only occupies a few minutes, can be performed by anyone who is capable of turning a tap, and it will be seen from the above that there is no handling either of the acid or the waste liquid, so that there is really nothing to "manage" in the whole affair from beginning to end, and since the battery itself only requires occasional addition of plain water, the total amount of attention demanded is far less than that occupied by the most trivial domestic operation.

With regard to the electro-chemical theory of the Upward battery fabricated by Mr. Walker, I can simply say it is utterly incorrect ; what really happens may thus be expressed :—

On *closing the circuit* the chloride of zinc is split up, the chlorine goes to the zinc plate while the freed zinc is passed on electrolytically to the outer cell ; this gives the full E.M.F., due to zinc combining with chlorine.

With regard to local action occasioned by foreign matter in the zinc, Mr. Walker must remember that the plate is simply immersed in its own chloride, and that under these conditions the loss is extremely small and quite negligible.

In conclusion, I may say that my apparatus does not require the services of the "nervous battery man," as there is really nothing for him to do. Any arrangement for domestic electric lighting which requires such an official would obviously be useless and out of the question.

With regard to bichromate batteries every one knows that for their size they are exceedingly powerful, but of course this is not to the point. They require emptying and filling with highly corrosive solutions, amalgamation of zincs, removal of plates when not in use, and are costly in working.

I may add just one word about the gas holder and its *absolute* freedom from smell.

All the lead joints are burnt, and the socket junctions of the earthenware pipes are filled in with about two inches of solid cement, and the whole is painted with a composition which is not in the least acted upon by the gas.

A. René Upward.

West Kensington, *July 7th*, 1886.

Primary Batteries.

I am pleased to observe by your article and repeated notes that a great interest is being taken in this subject at the present time. I am sure we shall all be glad to peruse Dr. Oliver Lodge's report when Mr. Upward has time to favour us with it.

I do not see, however, how Dr. Lodge's report can affect the practical side of the question. My objection is that the Upward battery is not an apparatus that can be entrusted to the manipulation of the ordinary domestic, whether male or female, with any hope of success, and for the reason that it is wanting in simplicity ; and in that sense it is, in my opinion, a step in the wrong direction. No amount of theoretical perfection will make up for this, and no amount of perfection in practical working so long as the apparatus is under the eye of the inventor or his trained staff, will ensure success under ordinary working conditions, if the working of parts of the apparatus are not easily understood by those who have to manipulate it, and are liable to get out of order, and I maintain that the "Upward" apparatus is full of such pitfalls. As to the question whether the apparatus as it stands is equal to the usual gas engine-dynamo plant, I should certainly by far prefer the latter. Experience has shown that gas engines are very reliable, and require very little attention ; while, as every electrical engineer knows, the attention required by the modern well-made dynamo is very small ; any good mechanic soon masters both. But in the case of the "Upward" apparatus we have all our experience to make ; and you have the drawback that a leakage of the chlorine gas might be attended with very serious consequences to the inmates of the house it was lighting.

The question of first cost is certainly more favourable ; but here I take the ground that it is not economical to have all this complicated series of apparatus, when you can have the same result at the same working cost, and with no such danger as attaches to the presence of chlorine gas. I maintain that the working cost of the battery, for which I gave the figures, will be less than that of the "Upward" apparatus ; and I think it must be apparent to every one that its first cost can only be a fraction of that of the latter.

In the matter of attendance, too, which must be a very important one in connection with these batteries, that required for Maquay's, now called, I believe, the "Regent," will be very much less than with the "Upward," so much so, in fact, that notwithstanding the very strong prejudice that a practical acquaintance with the working of electrical apparatus in the hands of the general public naturally engenders, I confess that the whole manipulation of the Regent battery has been rendered so simple, that I do not think a careful domestic, one who can be trusted to trim a paraffin lamp properly, would have any difficulty in doing all that is required ; that is, merely adding solution from day to day, or from week to week, as the case may be.

I am aware that it is stated that in the "Upward" battery only a little water is required occasionally ; but any practical electrician who will attentively peruse your very clear description of the apparatus will see that this is not so, and cannot be *all* that is required. Generator, bubbling bottles, receivers, delivery pipes, water seals, connections, aspirators, automatic contacts, all demand attention over and above that required to your *two* batteries, primary and secondary.

As I remarked in my former letter, we should give every credit to Mr. Upward for having boldly struck out a new line, and for the very careful way in which he has worked out the whole apparatus ; but I think a little practical experience of its use in untrained hands will convince him that no matter how perfect it may be theoretically, it will have to be more simple to become a success practically. Your remark *re* my comparison between the performance of the Regent and Schanschieff batteries is a fair criticism ; but you have omitted to take into consideration the relative size of the two batteries, which will fully bear out my contention. Further, those tests were taken before Christmas. In a recent test by an eminent electrician, I understand that the results I obtained were considerably exceeded.

Sydney F. Walker.

Cardiff, *July 6th*, 1886.

[We will ask Mr. Walker one question respecting the Maquay battery. Dare he in our columns bring before the notice of electricians, of course with the permission of those for whom it was written, his report thereon ? We venture to assert the contrary.—EDS. ELEC. REV.]